RETENTION OF YOUNG WOMEN IN HIGH SCHOOL SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS CAREER AND TECHNICAL EDUCATION PROGRAMS

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by

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RETENTION OF YOUNG WOMEN IN HIGH SCHOOL STEM CTE

The undersigned, appointed by the dean of the Graduate School, have examined the dissertation entitled

RETENTION OF YOUNG WOMEN IN HIGH SCHOOL SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS CAREER AND TECHNICAL EDUCATION PROGRAMS

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a candidate for the degree of doctor of philosophy

and hereby certify that, in their opinion, it is worthy of acceptance.

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CHAPTER 1: INTRODUCTION

One of the things that I really strongly believe in is that we need to have more girls interested in math, science, and engineering. We’ve got half the population that is way underrepresented in those fields and that means that we’ve got a whole bunch of talent...that is not being encouraged . . .

President Barack Obama
February 2013
(Office of Science and Technology Policy, 2013)

Background

As a school counselor in traditional high schools and a middle school, I worked with many students on course selections as well as the transition to postsecondary education and work. Across 20 years at schools in Pennsylvania, West Virginia, and Missouri, I noted fewer young women than young men enrolling in advanced math and science classes, particularly calculus and physics. Likewise, the number who planned to study science, technology, engineering, and mathematics (STEM) in postsecondary settings was higher among young men than young women. Instead of STEM fields, the majority of young women I counseled in grades six through twelve planned to enter the professions of education and healthcare, consistent with the U.S. Department of Labor Women's Bureau (2015) employment data. The data showed 56.7% of working age women were employed, with 42.9% being employed full-time. The industries where women accounted for more than half of all workers were the industry sectors of financial activities (53%), education and health services (75%), and leisure and hospitality (51%) (U.S. Department of Labor, 2014).

Statement of the Problem

Men, in overwhelming numbers, occupy the financially lucrative careers in STEM professions that are essential to the success of the national economy (Hill, Corbet, & St.
Rose, 2010; Smith 2013; Thomasian, 2011). The U.S. Department of Labor (2014) emphasized the disparity between the number of women and men employed in STEM occupations. For example, 26.1% of professional women filled positions in the fields of computer and mathematics.

Regardless of the growth of STEM careers (Terrell, 2007), women comprised only 14.1% of the positions in the architectural and engineering fields, compared to 90.1% of the jobs as registered nurses (U.S. Department of Labor, 2014). The lack of women in the STEM workforce is apparent, despite business and industry calling for increased workplace diversity (Hill et al., 2010; Smith 2013; The Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development, 2000; Thomasian, 2011; U. S. Department of Labor, 2009).

A survey of Fortune 100 (the top 100 companies of the Fortune 500) human resource executives championed diversity in the workplace, outlining the following reasons: “better utilization of talent; increased marketplace understanding; enhanced breadth of understanding in leadership positions; enhanced creativity; and increased quality of team problem-solving” (The Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development, 2000, p. 22). A second survey, with feedback from more than 1,000 members of the American Management Association, found “heterogeneity [in any profession]—a mixture of genders, ethnic backgrounds, and ages in senior management teams consistently correlated with superior corporate performance in such areas as annual sales, growth revenues, market share, shareholder value, net operating profit, worker productivity and
“total assets” (NSF, 2000, p. 22). Thus, there are important advantages in increasing the numbers of women in any workplace, including those in STEM.

Gender inequity in STEM careers is to a significant degree the result of greater numbers of women than men leaving the study of math and science in the junctures between high school, college, and the workforce. Blickenstaff (2005) used the metaphor of a "leaky pipeline" to describe the loss of STEM-trained women. He stated “the effect of differential leaking is to create a sex-based filter that removes one sex from the stream and leaves the other to arrive at the end of the pipeline” (p. 369). Blickenstaff also noted that the reasons for the leaky pipeline are complicated. For example, lack of mentors and role models in both high school and postsecondary education, a hostile work environment, challenges in balancing career and family, as well as few networking opportunities are some of the reasons women "leak" from the educational system and do not pursue science careers (Rosser & Taylor, 2008; Phillips, 2008). Despite these challenges, Bickenstaff argues the underrepresentation of women in STEM can be addressed. Potential remedies include: ensuring young men and young women equal access to classroom teachers and resources; using cooperative learning versus competitive events in K-12 education; eliminating sexist language and behavior in the classroom; and “openly acknowledging the political nature of scientific inquiry” (p. 384).

In order for the U.S. economy to "out-build, out-educate, and out-innovate future competitors," it is imperative that we “jump-start girls’ interest in STEM subjects,” which will in turn increase the number of women in science and engineering (Office of Science and Technology Policy, 2013, p. 1). To do so, educators at all levels should knowledgeably advise, support, and encourage all students with regard to projected
career opportunities in the U.S. workforce, particularly in the STEM occupations. Equally important is encouraging and supporting young women who show interest in STEM to continue to pursue STEM education, as well as intervening in practices that may marginalize young women. Retaining young women in STEM programs throughout K-12 education provides them with the experience and knowledge that will help to assure their success in postsecondary STEM majors. This, in turn, has the potential to increase the number of women ready to enter the STEM workforce.

**Purpose of the Study**

Although young women earn more high school math and science credits than young men, fewer young women than young men plan to major in a postsecondary STEM field (Hill et al., 2010; U.S. Department of Education, National Center for Education Statistics [NCES], 2009). In addition, while there is gender equity in high school math and science course enrollments, enrollment patterns in high school STEM career and technical (CTE) programs favor young men (Hill et al., 2010; Hyde, Lindberg, Linn, Ellis & Williams, 2008; “Perkins IV statewide performance,” 2013). For example, in 2012 nontraditional enrollment for high school young women in CTE programs was only 30% (National Alliance for Partnerships in Equity, 2012).

STEM CTE programs build on academic coursework, providing students with opportunities to apply their knowledge in real world work scenarios. For example, students in CTE coursework might design a bridge mock-up in a Project Lead the Way (PLTW) Civil Engineering and Architecture program and troubleshoot electronic devices used in engineering projects in a PLTW Digital Electronics course. Given the nature of these programs, it could be argued that increased participation in high school STEM CTE
programs could lead to larger numbers of women in postsecondary STEM programs, which, in turn, could result in higher numbers of women in the STEM workforce.

The exposure to high school STEM CTE has the potential to increase the self-confidence of young women as well as expose them to concepts and equipment not ordinarily familiar to them. Research shows that participation in high school STEM CTE programs also increases students’ applied knowledge of science and mathematics through project based learning (National Association of State Directors of Career Technical Education Consortium, n.d.). These experiences increase student learning, preparing them for the expectations and rigor required in postsecondary STEM degree programs (Association for Career and Technical Education [ACTE], 2013).

Increased retention of young women in high school STEM CTE programs has the potential to weld a patch in the STEM pipeline juncture between high school and postsecondary studies. Thus, the purpose of this study was to examine the retention of young women in STEM CTE programs. My study utilized an embedded multiple case study research design. The results from my could inform a plan to transform CTE into a setting in which more young women complete a STEM CTE program of study in high school and enroll in a related major at a college or university.

Increasing the diversity in the STEM workforce will yield the benefits described by The Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development (2000). An essential step toward diversity is understanding the experiences of young women in STEM CTE programs to ensure that all students have a welcoming and supportive classroom environment that encourages their retention in STEM CTE.
Research Question

I utilized the following overarching question for my research study: What influences young women to re-enroll or leave STEM CTE programs of study for another academic year at one CTE school in a small Midwest city?

Theoretical and Conceptual Framework

I identified liberal feminist theory and the concept of self-efficacy to frame my study and assist in understanding the factors that influence retention of young women in STEM CTE. The theoretical and conceptual frameworks were chosen because they provided a sociological and psychological framework to examine both the environmental structures and personal processes that supported or hindered a young women's desire to re-enroll in a STEM CTE program of study.

Feminist Movement in the U.S.

The feminist movement in the United States preceded the Frankfort School, with the first wave of feminism emerging in the mid-19th century. One of the defining events of the first wave was the women’s rights conference held in Seneca Falls, New York. It was at this conference that Elizabeth Cady Stanton outlined a “political strategy of equal access and opportunity” (Krolokke & Sorensen, 2006, p. 3). The first wave of feminism was intertwined with other reform movements of the time, including abolitionism and temperance (Rampton, 2015). Suffragettes challenged stereotypes of women, which included the proper way women should behave and talk (Krolokke & Sorensen, 2006).

The historical events of the 1960s women's movement marked the debut of the second wave of feminism and gave voice to new questions and concerns of inequality. The Redstockings and the New York radical feminists, as well as
other feminist groups, marked the beginning of the second wave by holding protests at the Miss America pageant (Rampton, 2015). These protests promoted the notion that women were intelligent, thinking human beings—more than just objectified sexual figures whose power derived primarily from assessment of their physical beauty (Krolokke & Sorenson, 2006).

The protests in the 1960s and 1970s marked the birth of the women’s liberation movement, which focused on the empowerment of women; one of the major objectives was to ensure control by women of their own reproductive health (Krolokke & Sorenson, 2006). The National Organization for Women (NOW) was established in 1966 and the introduction of the still-unlegislated Equal Rights Amendment in the U. S. Senate occurred in 1967. Millet, Morgan, Steinem, and Brownmiller authored publications on issues of gender inequality and educational publications on feminist philosophy began to appear (Tuana, 2011). Tuana notes that catalogued articles in the Philosophers Index with “feminism” as the keyword grew from three in 1973 to 718 in 1990, with 2,058 articles appearing by 2002.

As in the first wave, the second wave of feminism was intertwined with other issues of the time including protests of the Vietnam War, and the civil and gay rights movements (Krolokke & Sorenson, 2006).

The third wave of feminism emerged in the late 1990s with women “buoyed by the confidence of having more opportunities and less sexism” (Baumgardner & Richards, 2000, p. 83). Embracing “contradictory experiences” and deconstructing “categorical thinking,” third wave feminists sought to propose a different political agenda, one that challenged the idea of universal themes and
instead articulated the “ways in which groups of women confront complex intersections of gender, sexuality, race, class and age-related concerns” (Krolokke & Sorenson, 2006, pp. 16-17). Third wave feminism is often referred to as “grrl feminism” in the United States and “new feminism” in Europe. Key issues for third wave feminists are situated in a global context and include “violence against women, trafficking, body surgery, self-mutilation, and the overall ‘pornofication’ of the media” (Krolokke & Sorenson, 2006, p. 17).

**Liberal Feminist Theory**

Hatch (2002) delineates feminist scholars as those focused on issues related to gender. Liberal feminist believe freedom for women lies in the ability to have personal autonomy—living a life one chooses and political autonomy—being a co-author, with the state, of one’s life (Baehr, 2013). The goal of liberal feminism is equality of opportunity. Liberal feminists prefer androgyny as a descriptor of behavior versus characteristics associated with the behavior of men and women designated by socially imposed gender roles (Kemp & Brandwein, 2010).

Liberal feminist believe that the women’s movement should work to identify and address instances of injustice, working with the state to promote women’s legal rights to education and occupations (Baehr, 2013). Liberal feminist efforts to increase equity are the focus of NOW. Founded in 1966, NOW focuses on women’s employment opportunities, legal and political rights, education, women in poverty, the family, the image of women and women and religion (NOW, 2010).
Self-Efficacy

In Bandura’s (1986) social cognitive theory, he argued that individuals develop from more than a reaction to environmental forces; instead, they are self-organizing, proactive, self-reflecting, and self-regulating. A transition in Bandura's theory took place as his interest in self-regulative capacities and self-efficacy grew (Grusec, 1992, p. 777). Bandura believed that cognition played a crucial role in an individual's ability to construct reality, self-regulate, encode information, and perform behaviors (Pajares, 2002).

Pajares (2002) defined the central idea of social cognitive theory as the view that individuals are agents who can proactively make things happen in their environment by the actions they choose to take. Thus, individuals are proactive forces in their own development. Environmental factors—including socioeconomic status, educational background, and family dynamics—do not directly influence behavior, but instead affect self-efficacy beliefs, personal standards, emotional states, and other self-regulatory influences (Pajares, 2002).

Self-efficacy is at the root of social cognitive theory. Self-efficacy refers to "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). Pajares (2002) provides an example denoting the importance of self-efficacy using the prediction of how a term paper grade of B affects two different students. He states that an "A student" who worked hard on the paper will view the B in a very different way than a "C student" who worked equally hard. The "A student" will have writing confidence
"bruised," whereas the "C student" will receive a boost in self-confidence (Pajares, 2002, para. 15).

Bandura (1977) differentiates an efficacy expectation from an outcome expectancy, explaining an efficacy expectation as individuals’ "conviction" that they can successfully perform the behavior needed to achieve the desired outcome. He defines outcome expectancy as an "estimate" that a behavior will produce a certain outcome (Bandura, 1977). Bandura believed that the "strength of people's convictions" were likely to affect their willingness to cope in various situations. Individuals’ judgments of their self-efficacy in a particular environment, whether accurate or not, can lead them to either avoid activities that they believe exceed their coping ability or engage in activities that they feel confident in managing (Bandura, 1982).

Bandura (1982) states that early repeated failures—especially in the absence of adverse external circumstances coupled with individuals’ demonstrated efforts—can lower self-efficacy. Resultant misgivings can produce stress and affect performance as individuals personalize failings and possible mishaps instead of taking account of the strategies and personal strengths that will enable success (Bandura, 1986). The ability to visualize success, for instance, can influence the level of achievement and provide people with an advantage over others with equivalent ability whose pessimism precludes visions of success (Bandura, 1993). Students’ beliefs in self-efficacy can influence their aspirations, level of motivation, and academic accomplishments, ultimately affecting the breadth of career options they consider (Bandura, 1993).

Individuals’ families and friends play a role in self-efficacy, but Bandura (1986) believed that the time at school provided the most influential role on students’ cognitive
self-efficacy—because in a school setting students’ knowledge and thinking skills are continually tested, evaluated, and compared; therefore, school is a setting in which self-efficacy can either be empowered or diminished. More specifically, classroom practices that group by ability or produce a competitive environment can have a deficit effect on students’ self-efficacy. Likewise, classroom structures that place an emphasis on academic achievement via social-comparative versus self-comparative appraisal can negatively affect perceptions of cognitive ability (Bandura, 1986).

The use of self-efficacy in my study will assist in identifying experiences within the school setting that influence young women’s beliefs in their ability to succeed in the STEM CTE classroom. The pairing of liberal feminist theory with the concept of self-efficacy will enable me to observe not only the institutional and classroom structures but also the psychological factors that influence the retention of young women in high school STEM CTE programs of study. Identified practices and structures that empower or diminish young women’s self-efficacy and decision to re-enroll in STEM CTE programs can inform system changes needed to address inequities.

**Research Design**

To answer the research question, I employed an embedded multiple case study design. Creswell (2008) describes a case study as a type of ethnography through which a researcher “provides an in-depth exploration of a bounded system” (p. 476). Case study research employs the investigation of a “phenomenon (the ‘case’) in its real-world context” (Yin, 2011, p. 16; Yin 2015). Each young woman enrolled for the first time in a STEM CTE course in the 2015-16 school year will serve as a case.
Scholz and Tietje (2002) describe an embedded case study as an institution (case) where elements within the case are studied. By partitioning and compartmentalizing the case into elements a more refined analysis can take place (Scholz & Tietje, 2002). Yin (2015) states that a case study is needed when a researcher has the desire to “understand complex social phenomena,” focusing on the case while retaining a holistic and real-world perspective (p. 4). In my study, I want to understand why young women decide to stay or leave a STEM CTE program of study.

The young women participating in my study were representative of STEM CTE programs in an area career center. The area career center is located in a small Midwest city, home to a major university and two small colleges. Students from six county high schools, private and parochial schools, and students who are home schooled take CTE courses at the center.

The participants, young women completing the first year of a STEM CTE program of study, were interviewed. In addition to the interviews, observations and artifacts, including test scores and grades (math, science, and STEM CTE), were collected to assist with gaining insight to the factors that might influence the retention of young women in a STEM CTE program of study.

Triangulation of the data is important in a research study as it serves to verify a “particular event, description, or fact being reported by a study,” strengthening the trustworthiness of the inquiry (Yin, 2011, p. 81). In addition, Yin strongly encourages collecting and analyzing multiple data sources to enhance the depth of the case. In this particular study, interviews, artifacts, and classroom observations were used to triangulate the data.
Significance of Study

While I have found qualitative studies on CTE educators’ attitudes toward young women in nontraditional CTE programs (Morris, 2011) and young women’s perceptions of equity in a CTE construction tech program (Brookman, 2011), I have been unable to find a qualitative study regarding the retention of high school young women in STEM CTE programs. My study gave young women an opportunity to name the factors that either encouraged or discouraged them from re-enrolling in a STEM CTE program of study. Findings from my study may lead to recommendations for staff professional development, supply new direction to current support systems that work or are lacking, as well as identify implicit messages and structures that influence retention of young women in STEM CTE classrooms. Recommendations and implementation of reforms could foster young women’s self-efficacy and retention in STEM CTE program areas, which has the potential to improve gender equity in STEM and increase the number of women in STEM postsecondary majors and the workforce.

Definition of Key Terms

The terms necessary to understand this study are defined below.¹

_A+IT Essentials._ The class curriculum is focused on assembling and configuring a computer, installing operating systems and software, and troubleshooting hardware and software problems.

_Advisory._ A class that all 9ᵗʰ and 10ᵗʰ graders are assigned to at Rockledge High School². The class is facilitated by a teacher who assists students with study habits, career planning, and course selection.

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¹ Definitions of CTE programs have been taken from the course guide of the study site. Citing the definitions would jeopardize the confidentiality of the student participants.
American College Testing (ACT). A college admissions test which measures students’ readiness for college coursework (ACT, n.d.).

AP Computer Science A. The course curriculum is aligned with the curriculum standards established by the College Board, preparing students to take the AP Computer Science A exam. Students learn programming implementation, analysis, data structures, and standard operations and algorithms using the JAVA programming language (College Board, n.d.).

Area Career Center. A career and technical school that serves students who live in a specific geographic area.

Automotive Technology. The course curriculum follows the guidelines set forth by the National Automotive Technicians Education Foundation and includes eight major units: brakes, steering and suspension, engine repair, manual drive train, automatic transmission/transaxle, and heating and air conditioning repair.

C++ Programming. Students enrolled in C++ Programming must meet a math pre-requisite of a “C” average in high school geometry. The course teaches the C++ programming language which is a code used by leaders in the computer industry which includes Microsoft and Intel.

Calculus AB. The course is equivalent to the first semester of a college calculus course. Topics covered include: concepts and skills of limits, derivatives, definite integrals, and the Fundamental Theorem of Calculus (College Board, n.d.).

Calculus BC. The course is equivalent to the first and second semester college calculus course. Topics covered include differential and integral calculus which are used

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2High school name is a pseudonym used to protect the confidentiality of the student participants.
to approach calculus concepts and problems when they are represented graphically, numerically, analytically, and verbally (College Board, n.d.).

**Career and Technical Education.** Education that is occupationally-based, with a sequence of courses that prepares students for careers in high demand current or emergent employment sectors. Curriculum is competency-based and contributes to students’ "academic knowledge, higher-order reasoning and problem-solving skills, work attitudes, general employability skills, technical skills, and occupation-specific skills.” (Division of Academic and Technical Education, n.d. para. 2)

**Certified Welding.** This course follows the American Welding Society SENSE curriculum. Students weld steel plate utilizing Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW), Gas Tungsten Arc Welding (GTAW), and Flux Core Arc Welding (FCAW).

**Classroom structures.** Classroom procedures, textbooks, equipment, and group protocols used by instructors and students to organize and facilitate learning in the classroom.

**Computer Aided Drafting (CAD).** CAD is a class in which students learn AutoCAD, Architectural Desktop, and 3D Studio Max software. Students develop a portfolio over the course of the class which can be shown to postsecondary institutions for admission and credit for college coursework.

**Construction and Contracting.** The curriculum is designed to prepare students for a career in the residential and commercial construction industry. Students learn the basics of construction by building a home.
**Culinary Arts.** The course is accredited by the American Culinary Federation. Students are taught sanitation, knife cuts, stocks, vegetable and starch cookery, soups, and moist and dry cooking methods.

**Digital Media.** Students are introduced to Adobe Suite and utilize the software products to create digital collages, magazine covers, documentary and music videos.

**First Robotics.** First Robotics, often referred to as FIRST, sponsors state and national competitions in which high school teams compete with robots they have designed and built for the competitive event (FIRST More Than Robots, n.d.).

**Fixed Mind-set.** An individual’s belief that they are born with a certain intelligence that cannot be grown.

**Geospatial Technology.** Students learn and then utilize state of the art computer-enhanced information systems, satellite imagery, and global positioning programs to solve real-world problems.

**Growth Mind-set.** Individual’s belief that they can grow their intelligence by working through challenging material and with persistence succeed.

**Home Access.** The technology program utilized by students in the WVPS District to sign up for classes in the following school year.

**Information Technology.** Students utilize the Cisco Switching and Routing curriculum which addresses units on IP addressing, cable installation, and basic local area network (LAN) equipment set-up. At the completion of the course, students are prepared to test for the Cisco Certified Entry Networking Technician certificate.

**Laboratory Technology.** Students learn to use lab tools and procedures found in most industry research labs. Lab tools include an analytical balance, pH meter,
microscope, and micropipettes. Procedures taught include gram staining and aseptic technique.

*Laser Technology.* Students learn to create holograms, examine forensics, develop light shows, design security systems and examine other engineering applications that use lasers and fiber optics.

*Missouri Assessment Program (MAP).* The Missouri Assessment Program assesses students’ progress toward the Missouri Learning Standards, which are Missouri’s content standards, a rewrite of the national Common Core Standards (Missouri Department of, n.d.).

*Missouri Science Olympiad.* A non-profit organization affiliated with National Science Olympiad. The goal of the organization is to involve students in science education through participation in tournaments and non-competitive events (Missouri Science Olympiad, n.d.).

*Nontraditional student.* A student enrolled in a career program with less than 25% enrollment of students of the same demographic group. Female students are considered nontraditional students in STEM program areas (U.S. Department of Education, 2006).

*Photonics.* Students explore the physical control of light with an in-depth study of the physics of photonics. Photonics is a follow-up course to Laser Technology.

*Project Lead the Way (PLTW).* PLTW is a national provider of STEM curriculum, teacher training, and professional development (About PLTW, n.d.).
**PLTW Civil Engineering and Architecture.** Students are introduced to the planning, designing, surveying, and construction of infrastructures such as bridges, houses, dams and highways.

**PLTW Digital Electronics.** Students learn and work with analog and digital electronics. An introduction to troubleshooting, combinational and sequential logic design, engineering standards, and technical documentation are covered in the course curriculum.

**PLTW Introduction to Computer Science.** The course is designed for students who have never written code. Students complete a unit in Python coding, explore the impact of computing in society, and learn how computing applies in various career fields.

**PLTW Introduction to Engineering Design.** The purpose of the course is to introduce students to the design process, research and analysis, teamwork, engineering standards and technical documentation.

**PLTW Robotics and Computer Integrated Manufacturing.** Course curriculum covers the study of robotics, programming, and automation. Students gain experience with different types of robots and control systems as well as experiment with sensors, processors, and actuators used in manufacturing.

**Retention.** Enrollment in a STEM CTE program of study in the 2016-2017 school year by young women who completed a STEM CTE course in 2015-2016.

**Saturday Morning Science.** A series of one hour science presentations on a variety of subjects. The talks are held at the local university in the same town as Winter Valley Public School District.
Scaled score. Test scores that have been mathematically converted from raw test scores (total number of questions a test taker answers correctly) to another set of numbers that make them comparable across different editions or forms of the same test (Tan & Michel, 2011).

Self-efficacy. Individual's judgment of their capability to successfully perform a task.

Sending school. School where a student is registered and completes their core academic subjects.

STEM CTE programs of study. State approved CTE courses that are part of an engineering program of study. STEM CTE programs of study included in my research are: C++ Programming, PLTW Introduction to Computer Science, PLTW Introduction to Engineering Design, and PLTW Digital Electronics.

Winter Valley Public School District math sequence. The prescribed college-preparatory sequence is: Algebra 1, Geometry, Algebra 2, Pre-Calculus, Calculus AB, Calculus BC.

Winter Valley Public School District science sequence. The prescribed college-preparatory sequence is: Physics, Biology, Chemistry, and then a choice of AP Physics, AP Chemistry, or AP Biology.

Summary

Men significantly outnumber women in postsecondary STEM majors and the STEM workforce (Hill et al., 2010; U. S. Department of Education, 2006; U. S. Department of Labor, 2003, 2009;). The gender imbalance will continue in the foreseeable future because fewer young women than young men plan to enroll in a STEM
postsecondary major (Hill et al., 2010). A measure toward changing the status quo, retaining young women in high school STEM CTE programs, could ultimately raise the number of women in the STEM workforce. Increasing the number of women in STEM postsecondary majors and in the workforce will likely assist in reducing the earning differential between men and women and produce the added benefit of creating a leadership pool with enhanced creativity, team problem-solving, and marketplace understanding (Hill et al., 2010; Smith 2013; The Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development [The Congressional Commission], 2000; Thomasian, 2011; U.S. Department of Labor, 2010).

This qualitative study explored the factors that influence the retention of young women in a secondary STEM CTE program. A qualitative study of this nature is important, as no other studies of this type have been found in the literature to date. The findings from this study may provide educators with information regarding structural supports needed to retain young women in STEM CTE programs of study, and ultimately in postsecondary STEM majors and the STEM workforce. The study explored a juncture in the STEM pipeline that, if better understood, could assist in addressing the concerns President Obama referenced at this chapter’s onset.
CHAPTER 2: LITERATURE REVIEW

Young women are earning high school math and science credits at the same rate as young men (Hill et al., 2010; U.S. Department of Education, 2009), which prepares them to leave high school to study STEM in college. Despite this, men outnumber women graduates in most science and engineering fields in college, with the most significant differences occurring in physics, engineering, and computer science where only 20% of the graduates are women (Hill et al., 2010).

The juncture between high school and college is what Hill et al. (2010) calls a "critical time" when women often turn away from a career path in STEM (p. 5). However, women opt out of STEM at each education juncture in the STEM pipeline—beginning in middle school and continuing through graduate school (Blickenstaff, 2005). As such, retention of young women in STEM is a major issue for the U.S. economy (Beede et al., 2011). Increasing the number of women in the STEM workforce will maximize "innovation, creativity, and competiveness" (Hill et al., 2010 p. 3). In addition, because the needs of women are often overlooked, women are critical in product design (Hill et al., 2010).

Career and technical education provides the training that addresses employment needs for high growth industries such as healthcare, renewable energy, and STEM—all sectors that are central to the economic future of our country (National Association of State Directors, n.d.b). Because federal funds are specifically designated for CTE, area career centers are able to provide settings where young women can begin studies in STEM, building on their academic math and science knowledge. Yet, as previously mentioned, even with some young women pursuing careers in STEM, young women are
opting out of many STEM CTE classes, including engineering and computer programming, and ultimately careers in STEM.

To set the stage for my study, I reviewed literature that defines the parameters and history of CTE in the U.S. The remaining sections focus on themes affecting the retention of girls and young women in STEM. Although presented separately, the themes often overlap and have been found to affect girls in elementary school, young women in secondary education, as well as women in undergraduate and graduate STEM majors. In order to understand the leaky pipeline, themes throughout K-12 must be examined as they may affect a young women’s self-efficacy and mind-set regarding the continuation in a STEM major in postsecondary education.

**Career and Technical Education**

Career and technical education is found in every state in the United States. Its curriculum is delivered in comprehensive high schools, area career centers, career academies, technical and community colleges, as well as 4-year universities (ACTE, n.d.). Nationally, 94% of high school students and 12 million postsecondary students are enrolled in CTE programs (ACTE, n.d.).

Enrollment in career and technical education has become an avenue for many students to make a seamless transition into college and the workplace. The National Association of State Directors of Career Technical Education Consortium state the key “principle that connects and defines all Career Technical Education” is that it draws its “curricula, standards, and organizing principles from the workplace” (National Association of State Directors, n.d.a, p. 3). In fact, the workplace defines career and technical curricular objectives, organization of course content, assessments, and
performance standards for workplace readiness including academic, technical, and employability skills (e.g., ability to take initiative and work well in a team, punctuality, and dependability).

Career and technical education is unique because of its collaboration with local business and industry, as well as its designated funding source from the federal government, funneled through state grant dollars specifically designated for CTE education (Carl D. Perkins Career and Technical Education Improvement Act of 2006; Missouri Department of, 2014; Nicastro, 2015). Further reinforcing the strong relationship with the workplace, CTE instructors are required to meet with their program area advisory committee, comprised of members from business and industry, twice yearly to review curriculum and workplace performance standards. Advisory committees help to ensure that CTE coursework is current, preparing CTE students for the transition to postsecondary education and work (Missouri Department of, 2014).

**Emergence of CTE in the United States**

Federal funding for vocational education was nonexistent until President Woodrow Wilson signed the Smith-Hughes Act in 1917. Senator Hoke Smith and Congressman Dudley M. Hughes were ultimately responsible for putting the act before congress, with strong advocacy from the National Society for the Promotion of Industrial Education. Known by many as the “Magna Carta of vocational education,” the Vocational Education Act of 1917 designated federal funds in the amount of $1.86 million for vocational education (Foster, 1997; Smith 1999).

The Smith-Hughes Act and supporters of successive legislation allowed for continued funding to vocational education, viewing it as an avenue to retain students in
school and train workers for an expanding number of semi-skilled jobs (Gordon, 2003).

By the 1960s, vocational education was still taught to students in area vocational schools. Instruction expanded to comprehensive high schools and additional vocational programs emerged including business and commerce classes.

By the mid-1980s, school reform efforts proliferated in large response to the 1983 publication of *A Nation at Risk*. The report highlighted the United States’s falling status in global economic competition:

Our Nation is at risk. Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world. This report is concerned with only one of the many causes and dimensions of the problem, but it is the one that undergirds American prosperity, security, and civility… What was unimaginable a generation ago has begun to occur--others are matching and surpassing our educational attainments.

(U.S. Department of Education, 1983, para. 1)

After the publication of *A Nation at Risk*, one of the educational reforms was the passage of The Carl D. Perkins Vocational Education Act of 1984. The act expanded vocational education objectives beyond the training of young men and women for entry-level workforce employment (Lewis & Kosine, 2008)—it “provided for modernization and program improvement in vocational education,” addressing the needs of special populations by “ensuring access to quality programs” for the disadvantaged, people with disabilities, individuals entering occupations nontraditional for their sex, single parents or homemakers, adults in need of training or retraining, individuals with limited English proficiency, and individuals who were incarcerated (A New Age of, 2002, p 40).
Although there were changes in content and focus, language pertaining to gender equity has been a constant in Perkins legislation. In particular, the first Perkins legislation passed in 1984 encompassed the promotion of sex equity in vocational programs. It specifically stated that a small portion of the Basic Grant was set aside to promote enrollment and retention in vocational education programs nontraditional for a student’s gender (Muraskin, 1989).

In addition to the aforementioned Perkins objectives, the fourth authorization of the act (2006) contained themes that called for: accountability for CTE results and program improvement; increased coordination of CTE curriculum between secondary and postsecondary; stronger academic and technical integration; and connections between secondary and postsecondary education, business, and industry. Additionally, the term “vocational education” was renamed “career and technical education” (U.S. Department of Education, 2006).

Perkins IV has emphasized local accountability by requiring CTE programs to set specific performance indicators for each of the Perkins objectives with targets coinciding with state goals; CTE programs that are not compliant with state performance goals are required to develop improvement plans outlining measures to meet state performance standards (U. S. Department of Education, 2006). One of the state performance standards is the annual reporting of enrollment and retention of students in CTE programs nontraditional for their gender.

Addressing gender equity in STEM should be a priority. However, to do so, it is important to understand some of the contributing factors that discourage young women from considering a future in STEM. CTE programs play an integral role in addressing
the STEM employment challenge, as well as securing the United States as a leader in innovation (Association for Career & Technical, 2009). CTE offers students a deep understanding of STEM fields, brings relevancy to math and science content, and helps to grow the STEM pipeline by encouraging students from underrepresented groups to participate in STEM CTE programs, preparing them to enter STEM career fields (Association for Career & Technical, 2009).

Local and state CTE programs, as well as the national Association for Career and Technical Education, work diligently to develop strategies to increase nontraditional student enrollment in CTE. National as well as state conferences have dedicated workshops focused on increasing the enrollment of young women in STEM programs (Center for STEM Education for Girls, 2015, Missouri Girls Collaborative STEM Initiative, 2014). Despite these efforts, reaching state performance indicators for the participation and retention of young women in program areas nontraditional for their gender remains a challenge for many CTE programs (Missouri Department of, 2013), consistent with overall national trends regarding women in the STEM workforce.

**Retention of Young Women in STEM**

In many STEM programs the enrollment and retention of young women is a problem (Hill et al., 2010). Lufkin et al. (2010) state that the “key gender-equity challenge for CTE is the elimination of sex bias and stereotyping that leads to limiting students’ career choices” (p. 422). Lufkin et al. underscore the importance of young men and women making career choices based on their interests, skills, and talents. They emphasize that in addition to an individual’s personal career fulfillment, there is the potential benefit to society—increasing the diversity of the workforce; improving gender
equity in earnings; maximizing the use of an individuals’ talents; and increasing the United States’s ability to compete in a global economic marketplace (Lufkin et al., 2010). The remaining portion of the literature review focuses on factors that affect the retention of young women in STEM secondary and postsecondary programs. I present literature about the postsecondary context, as I am interested in the transition between secondary and postsecondary education. The most salient factors I introduce below are: self-efficacy, mind-set, and grit, stereotype-threat, role models, and chilly climate.

**Self-efficacy, Mind-set, and Grit**

Bandura (1977) defined efficacy expectation as an individuals’ "conviction" that they could successfully perform a behavior needed for a desired outcome. He believed that individual judgment of self-efficacy in particular situations (whether that judgment was accurate or not) led them to either avoid or engage in activities based on their confidence to manage the situation (Bandura, 1982). Bandura (1986, 1997) stated that people form their self-efficacy beliefs through mastery experiences, vicarious experiences, verbal persuasions, and physical and emotional states. Once efficacy beliefs were formed, they contributed to “the level and quality of human functioning” (Bandura, 1993, p. 145). Carol Dweck, Bandura’s colleague (Stanford University, n.d.), also studied how learners’ level of confidence in their intelligence can determine the manner in which they will approach and have success at a task. In particular, in graduate school, Dweck became interested in Martin E. P. Seligman’s model of “learned helplessness;” Seligman’s model spurred her on to study how people cope with failure (Glenn, 2010).

Dweck (2006) developed the concept of mind-set, labeling individuals’ mind-sets as either "fixed" or "growth." Dweck describes a fixed mind-set as the belief that
intelligence, personality, and moral character are determined, whereas a growth mind-set is the belief that one can grow these qualities through application and experience. Individuals with a growth mind-set champion challenges, persist in the face of setbacks, see effort as a path to mastery, believe that they can learn from criticism, and find lessons and inspiration in the success of others (Krakovsky, 2007). Dweck suggests the absence of a growth mind-set as one of the reasons women are derailed from pursuing studies in STEM (Jones, 2010).

A collaborator of Dweck’s, Angela Duckworth, would describe grit as another piece of the equation for successful mastery of new concepts (Perkins-Gough, 2013). Duckworth, describes a person with grit as not only having resilience, but also having a passion and perseverance to achieve long-term goals (Peterson, Matthews, and Kelly, 2007). Duckworth and Dweck have found that students who have a growth mind-set are grittier (Perkins-Gough, 2013). Duckworth reports that it is not a perfect correlation, but the idea that one can get better by trying harder should help individuals become a “tenacious, determined, hard-working person” (Perkins-Gough, 2013, p. 19).

Grit, as defined by Duckworth, encompasses resilience, passion, and perseverance towards a long-term goal. Duckworth’s theory of grit is not without critique; for example, it has been challenged by Crede, Tynan, and Harms (2016). They conducted a meta-analytic review of the grit literature, with a focus on the relationship between grit and performance, retention, conscientiousness, cognitive ability, and demographic variables. Their findings suggest that Duckworth’s scale for grit should be scrutinized and that grit researchers give a greater focus to the role of perseverance.
Whether one defines a student’s personality trait as grit, perseverance, or conscientiousness, one or all of these traits have been evidenced as affecting one’s tenacity to stay with a task. This, in combination with self-efficacy and a growth mindset, have shown a positive effect in students’ willingness to tackle challenging work.

**K-12 studies.** All students, including young women, who have self-efficacy in STEM typically perform better and persist in the face of challenge than those with lower STEM self-efficacy (Britner & Pajares, 2006; Felder, Felder, Mauney, Hamrin, & Dietzmu 1995; Linver & Davis-Kean, 2005; Mau, 2003; Zeldin & Pajares, 2000). However, young women tend to “have a lower opinion of their capabilities for mathematical activities than do young men even though they perform equally well in this subject” (Bandura, 1997, p. 430). Research by Linver and Davis-Kean (2005) support Bandura’s assertion. They reviewed data from the Michigan Study of Adolescent Life Transitions (MSALT), an 18 year study of adolescents’ ratings of school transitions and family environments. MSALT data included information on students’ interest, motivation, and achievement-related self-concepts. Although they found young women’s math grades were higher than young men’s, young women’s self-concept of their math abilities appeared to be the stronger influence for them deciding not to continue in a physical science or information technology career path.

Not only do young women have a diminished view of their mathematical ability, they hold similar perceptions in science. Lupart, Cannon, and Telfer (2004) found that young men had higher interest and perceived ability in science than young women. In addition, young women perceived they needed to work harder in science to make good grades. Britner and Pajares (2006) stated that students who have a strong belief in their
ability to succeed in science work hard to successfully complete the task and persevere when they face difficulties, consistent with Dweck’s (2006) research. Students who do not have a belief that they can succeed tend to avoid science activities if they can and exert minimal effort if an activity cannot be avoided. In addition, they found that young women reported more anxiety about their performance in science coursework, while feeling confident about their overall ability to manage their studies. Just like in math (Linver & Davis-Kean, 2005), young women earned higher final grades in science and their success did not result in their assessment of a higher science mastery experience, science self-efficacy, or science self-concept.

Blackwell, Trzesniewski, and Dweck (2007) conducted two studies over different time intervals, with the first occurring over a period of 5 years. Both studies involved students in the New York City (NYC) school system; one study was conducted in a school with a higher performing average as compared to the mean for other NYC students. Students in both studies were administered a motivational questionnaire assessing students’ "theory of intelligence, goals, beliefs about effort, and helpless versus mastery-oriented responses to failure" (Blackwell et al., 2007, p. 249). In the first study, students who held the belief that intelligence was not fixed maintained learning goals, and held to the concept that working hard was necessary to academic achievement. When setbacks occurred, these students were more likely to invest more effort or change strategies than students who had a "fixed" view of intelligence.

The second study by Blackwell et al. (2007) used a different protocol after the motivational questionnaire was administered. Students were divided into control and experimental groups, with the experimental group receiving instructions based on
"incremental theory"—that intelligence is malleable. The experimental group received an intervention protocol that included a reading entitled, "You Can Grow Your Intelligence," a neural network maze (demonstrating that learning makes your brain smarter), and a study skills lesson. The students in this group also discussed how learning can increase intelligence and the importance of not labeling others as stupid.

The control group had alternative lessons for each of the aforementioned activities. Both groups received lessons on the brain's structure and function and an anti-stereotyping lesson. Findings showed improved math grades from the incremental theory interventions; “fixed mind-set” students in the control group had a decline in math grades. Blackwell et al.’s findings supported their hypothesis that student academic achievement is directly affected by an incremental theory message. Both of these studies reflect the importance of self-efficacy and a growth mind-set.

Self-efficacy beliefs are based on "mastery experience, an individual's task-specific experiences, and interpretation of those experiences" (Rittmayer & Beier, 2009, p. 2). Moreover, students’ self-efficacy is a cyclical and reciprocal event—individuals’ perceived successful performance of a task results in setting more difficult goals that in turn requires them to put forth greater effort, which can positively affect performance. The completion of a new, more difficult goal based on previous performance then leads to greater self-efficacy with the cycle continuing (Rittmayer & Beier, 2009).

Self-efficacy and growth mind-set research is relevant to young women in STEM programs. For example, Good et al. (2003, 2009) found that a growth mind-set rooted in strong self-efficacy protected young women from the stereotype that they are not as good as young men in math. However, when self-efficacy is questioned:
even women who persist in mathematics remain at a higher risk of failure than their abilities would predict, because their expectations lead them to limit their efforts when they encounter difficulties. Instead of trying harder, they try less hard, or give up (Valian, 1998, p. 157).

Negative self-efficacy messages are prevalent for young women. For example, Catherine Didion, executive director for the Association for Women in Science, testified before Congress stating, "Barbie dolls have been manufactured to say math class is tough. A girl who is having trouble with math is often told that her difficulties are normal, rather than being challenged to improve" (The Advancement of Women in Science, Engineering, 1998, p. 24). With such messages, it follows that some girls and young women will abandon STEM pursuits (Valian, 1998).

**Postsecondary studies.** Self-efficacy in mathematics and science is not only an issue for young women in middle and high school, it also is a factor for undergraduate women in STEM majors. In 1991, the Women in Engineering (WIE) Initiative at the University of Washington conducted a 6-year longitudinal study of science and engineering undergraduates. The initiative had three objectives: determining an accurate retention rate for women science and engineering students; examining the factors that affected the retention rate; and evaluating the effectiveness of WIE's programs targeted at increasing recruitment and retention of women in science and engineering. WIE's interventions occurred primarily during participants’ first and sophomore years, as those are the times when most attrition occurs (Brainard & Carlin, 1998).

Brainard and Carlin (1998) found that students tended to leave STEM for several reasons including being attracted to another academic field, being discouraged by
academic difficulties, and perceived low grades. While there were differences in the self-confidence between women who persisted in science and engineering and those who switched to a non-science major, grade point averages (GPA) between the two groups were not significantly different. Like the K-12 studies, students who persisted in science and engineering maintained high levels of math and science self-confidence and indicated higher initial self-confidence levels. These students also noted other factors that were related to persistence, including "interest in coursework, positive relationships with faculty/TAs, involvement in student societies, seminars, conferences and events, and participating in internships" (Brainard & Carlin, 1998, p. 375).

In another study focused specifically on undergraduates in engineering, Jackson, Gardner, and Sullivan (1993) found the best predictor of persistence for both men and women was GPA. Other predictors were dependent on gender. Even though persisting women performed better than persisting men, they rated their academic abilities lower. Results showed women rated career advancement as less important than men, instead placing an emphasis on hard work, suggesting a growth mind-set (Dweck, 2006). Unlike women, men indicated the competitive environment as a route to success. Women in the study were also more aware of support services on campus than men. However, Jackson et al. stated that it was difficult to detect what the influence of support services was for those women who continued to persist in engineering versus those who did not. A common theme in Jackson et al. and Brainard and Carlin (1998) findings was that women rated their academic ability lower, despite performing at the same level or better than men in science and engineering coursework.
The analyses by Jackson et al. (1993) and Brainard and Carlin (1998) have continued support in other studies (Vogt, Hocevar, & Hagedorn, 2007), including a meta-analysis of studies about self-efficacy and academic performance of women in STEM (Singh, Allen, Scheckler, & Darlington, 2005). The women in Vogt et al.’s (2007) study, as well as Singh et al.’s (2005) meta-analysis, rated themselves lower than men in self-confidence in computer related tasks, despite evidence of equal or superior academic ability. Vogt et al., like Jackson et al., found that women believed they had to work harder than men and seeking the extra help to do so. Additionally, Singh et al. found women’s primary computer usage was for texting and social interaction, whereas men had experience not only in gaming, but also installation of computer hardware, perhaps also lending to women’s lack of self-confidence in computer related tasks.

In their study, Zeldin and Pajares (2000) sought to uncover factors that enhanced positive self-efficacy of women in STEM. They found that vicarious experiences and verbal persuasions were “instrumental sources for the development and maintenance” of their self-efficacy beliefs (Zeldin & Pajares, 2000, p. 227). Further, early exposure to math through experiences shared with family members who excelled, or were interested in mathematics, added to the participants’ self-efficacy. Specific examples of verbal persuasion that were found particularly influential in building positive self-efficacy were support from a father who emphasized practice as the key to success in math and other family members’ encouragement to enter a STEM career path.

**Stereotype-threat**

Another factor that researchers have found to affect persistence is stereotype-threat. Stereotype-threat is defined as “being at risk of confirming, as self-characteristic,
a negative stereotype about one’s group” (Steele & Aronson, 1995, p. 797). Steele and Aronson (1995) first used the term in their study of academic test performance by African American college first year and sophomore students. They found when African American students knew race was a demographic variable being collected in the study, they performed worse on standardized tests than Whites. However, when race was not stressed as a part of the study, the students performed better or the same as White students. The study evidenced the effect racial stereotypes can have on academic performance when achievement is viewed through the lens of race.

Building on Steele and Aronson’s (1993) study about race, stereotype-threat based on gender has been most studied in the area of mathematical achievement (Johns, Schmader, & Martens, 2005; Keller & Dauenheimer, 2003; O’Brien & Crandall, 2003; Steele, 1997). Understanding this phenomenon can assist in comprehending how stereotypes undermine young women’s interest and achievement in STEM “even when women and girls have positive math attitudes” (Shapiro & Williams, 2012, p. 175).

**K-12 studies.** Steele and Aronson’s (1993) research has fostered similar research focused on gender beliefs held by students in K-12. Ambady, Shih, Kim, and Pittinsky (2001) conducted a study of stereotype beliefs in children in the lower elementary grades (kindergarten-grade 2), upper elementary grades (grades 3-5), and middle school grades (grades 6-8). Although younger children were not aware of stereotypes, Ambady et al. noted that they do recognize social categories. When gender identity was the focus, younger girls performed significantly worse on mathematical tests than boys—the same pattern held true for middle school young women. However, performance differences were not seen between boys and girls in the upper elementary grades. Ambady et al.
believe a difference was not documented because boys and girls in the upper elementary grades are extremely competitive when it comes to their gender identity, often feeling their gender is superior to the other. Between upper elementary and high school, this gender confidence dissipates.

At the high school level, Danaher and Crandall (2008) studied the effect of stereotype-threat on young women taking the Advanced Placement Calculus AB exam. One group was asked to report their gender at the onset of the test, while the other group did not report gender until finishing the test questions. Test results showed that the young women required to report gender prior to taking the test had a reduced test performance of 33%. Similar results were found by Keller and Dauenheimer (2003) in their study of 15-year-olds at a German secondary school. Students were administered a mathematics test in which one group was told that past test results had shown gender differences (high stereotype-threat), whereas the other group was told that there were no score differences by gender. Young women in the high stereotype-threat group scored significantly lower than young men, while young women in the non-threat environment scored comparably to young men.

**Postsecondary studies.** Johns et al. (2005) utilized three groups of undergraduate students to measure stereotype-threat in mathematical achievement. The first group was told that their test scores were going to be used to compare men’s and women’s mathematical ability; the second group of students were told that they were being given a problem-solving exercise; and the third group of students were tested under the same conditions as the first group, but were told that stereotype-threat could interfere with their performance. Results showed that women performed worse than men when
they were told that they were taking a math test in which their abilities would be compared to those of men. However, women’s scores did not differ from men’s when they performed the problem-solving exercise or when they were informed about stereotype threat. Thus, Johns et al. determined that a teaching-intervention can be helpful to increase women’s scores in testing situations where test anxiety can be attributed to gender stereotyping, suggesting that a growth mind-set is possible (Dweck, 2006).

Additional research on stereotype-threat among undergraduate students includes studies by Cadinu, Maass, Rosabianca, and Kiesner (2005), Schmader and Johns (2003), and Van Loo and Rydell (2013). Cadinu et al. focused on the effect negative thoughts can have on student test scores. The study involved 60 undergraduate students who were separated into two groups: the stereotype-threat condition group and the control group. Both groups were given difficult math problems, similar to those on the Graduate Records Examination (GRE). Women in the stereotype-threat group were told that research has shown there is a difference between scores of men and women when completing logical mathematical tasks, whereas women in the control group were told there are no differences in scores. Additionally, participants in both groups were given a blank piece of paper and told to write their thoughts down as they completed the math test. As the researchers predicted, the women in the stereotype-threat group underperformed as compared to women in the control group. Building on the work of Steele and Aronson (1995), they demonstrated a link between negative thinking and poor performance, noting that the decrease in performance was linked to an “increase in negative domain-specific thinking” (p. 576).
Schmader and Johns (2003) found similar results among men and women psychology students. Their study also considered the role of stereotype-threat on working memory capacity. As anticipated, they found that members of stigmatized groups perform more poorly on cognitive tests, when “negative stereotypes have been primed,” interfering with “attentional resources” (Schmader & Johns, 2003, p. 449).

Van Loo and Rydell (2013) also studied stereotype-threat on math performance, but the methodology they used was different than in the aforementioned research. Their experiment consisted of 234 undergraduates randomly assigned to watch videos of male-female interaction related to a general study group and a math study group. The videos consisted of one in which a man was dominate, another in which a woman was in control, and the third in which men and women had equal roles. After watching the videos, participants were asked to complete 30 GRE math problems in 20 minutes. Results showed decreased math performance and greater worry about conforming to negative stereotypes for women who watched the video in which the man was dominant. No performance deficits or associated worries were noted for the women who viewed the videos in which the woman was in an equivalent or in a dominate role to the man. Their findings, like the other research discussed, continued to reinforce the powerful role stereotypes play in women’s perceived and actual capacity to succeed mathematically. Such results likely influence whether women persist in STEM if they receive negative messages about whether they belong in STEM (Hill et al., 2010).

Role Models

K-12 studies. Researchers have found that socially constructed ideas of who is a scientist and whether there are ample same-gender role models can influence decisions
about pursuing science (Burke, 2007). For example, Mead and Mattraux (1957) were the first to identify a sex-stereotyped image of a scientist by high school students. They analyzed a nation-wide sample of essays in which young men and women were asked to complete the sentence: “When I think about a scientist, I think of . . . ,” young men were also asked to complete the sentence: “The kind of a scientist I would like to be . . . ,” and young women were given the choice to respond to the question the young men were asked or to finish the statement: “If I were going to marry a scientist, I would like to marry the kind of scientist who . . .” (p. 385). The analyses showed both young men and women had a shared picture of a scientist as a “man who wears a white coat and works in a laboratory” (Mead & Mattraux, 1957, p. 386). Despite the shared image, the remaining statements completed by young men and women demonstrated a divide in attitude. Statements young men completed regarding the kind of scientist they would like to be ended with sentiments of adventure, space, and travel, while young women’s answers emphasized a more humanitarian stance—reflecting “self-sacrifice for humanity” (Mead & Mattraux, 1957, p. 387). Young women in mass rejected science as a career, stating that they wanted to be involved with people rather than things—they also were not in favor of their husbands pursuing a career in science, feeling it would involve them in dangerous pursuits and interests that could not be shared.

Mead and Mattraux (1957) shed light on the stereotype that both high school young men and women had regarding the gender of a scientist. Although their study reflected stereotypes held by both young men and women in the ‘50s, a study today might yield similar results. The National Science Foundation (2015) reports that women fill only 20% of the positions as physical scientists and 23% of the jobs as computer
scientists. The lack of women role models in the sciences may be why it is difficult for young women to envision themselves as scientist (Moriarty, Howe, & Yasinski, 2013).

Young women enter the STEM pipeline when they begin receiving science and math instruction in elementary school—primarily having women as instructors (Rich, 2014). As important as it is for girls to see women teaching science and math in elementary school, it is also of value to have women role models in grades 6 through 12, where the majority of science and math teachers are men (Blickenstaff, 2005; Britner & Pajares 2006; Jones, 2010; Mitchell & Hoff, 2006; Programs and Practices That Work, 2009). Britner and Pajares (2006) state modeling is effective when observers perceive a similarity between themselves and the role model. A role model can help “instill self-beliefs that will influence the course and direction that his or her life will take” (Britner & Pajares, 2006, p. 487); therefore, having a same-gender role model could encourage a young woman to continue studies in a science or math career path. Baker and Leary (1995) noted that young women with the strongest commitment to a career in science learned to “love science through the love of a parent or grandparent involved in science” (p. 25). Likewise, young women need to see same-gender science role models in textbooks and in the media. Young women noted bias in textbooks (Brotman & Moore, 2008) as well as on television where few scientist were depicted as women (Baker & Leary, 1995).

In addition to young women having contact with women role models, Mitchell and Hoff (2006) assert the importance of emphasizing the achievement of women in science. Greene, Sullivan, and Beyard-Tyler (1982) asked 288 students in grade 9 to read interviews about people in careers that were nontraditional for their sex. After reading
the interviews, both young men and women were asked to rate occupations as male, female, or both. Results showed that both young men and women assigned the response of “both” to jobs that were stereotypically male or female; however, young women assigned “both” more often than young men. Based on the results of their study, student attitudes toward sex-typed careers could have the potential to change by reading material about nontraditional role models (Greene et al., 1982).

Buck, Clark, Leslie-Pelecky, Lu, and Cerda-Lizarraga (2007) found that while seeing a scientist who looks like them is important, young women needed affirmation that went beyond having contact with women in science careers. After reviewing transcripts from three focus groups conducted over a 6 month period, the 8th grade young women identified a science role model as someone who knows about science and has a good personality. A good personality was defined as having characteristics that included kindness, intelligence, helpfulness, and a good sense of humor. The young women “sought a personal connection of intimacy and care;” therefore, in order for a woman scientist to be a positive role model for the young women, the woman scientist had to be someone “who cared about them and shared common interest/experiences” (Buck et al., 2007, p. 703). These attributes, like other influential factors, are important to keep in mind if schools are truly committed to increasing the numbers of young women in STEM.

Postsecondary studies. Not only are role models important in K-12 education, but they continue to play an important role in postsecondary education (Griffith, 2010; Macfarlane & Luzzadder-Beach, 1998). The lack of role models at all levels has an additive effect—fewer women role models result in decreased retention of young women
in high school math and science, as well as women undergraduate STEM majors (Drury, Siy, & Cheryan, 2011; Encouraging the Participation, 2009; Lockwood, 2006; Marx & Roman, 2002). The consequence of low numbers of women STEM college graduates is a STEM workforce comprised of few women who can serve as role models (National Women’s Law Center, 2012). Increasing the number and availability of women scientists is linked to the academic success of young women in STEM, as well as to the impetus of undergraduate women to pursue advanced degrees in STEM which reinforces the need for women role models (American Society for Engineering Education, 2006; President’s Council of Advisors on Science and Technology, 2012; Stout, Dasgupta, Hunsinger, & McManus, 2011; Toglia, 2013; The Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development, 2000; U.S. Government Accountability Office [GAO], 2004).

Macfarlane and Luzzadder-Beach (1998) recommend all undergraduate and graduate women have mentors so that they see women as a part of the STEM workforce instead of an “anomaly or aberration” (p. 1591). Highlighting the influence of women role models and mentors, Duncan and Zeng (2005) found persisters in undergraduate engineering programs viewed women in the field as sources of encouragement. For example, one student in the study stated that the research and teaching passion of a woman civil engineering professor had inspired her to be a “driven person” (Duncan & Zeng, 2005, p. 18). Moreover, Nauta, Epperson, and Kahn (1998) found the achievement in STEM academic goals was related to higher level career aspirations which may be attributed to the positive influence of a STEM role model.
Women alumnæ from a small Midwest university known for its engineering programs echoed the importance of same-sex role models (Robinson & Reilly, 1993). They found that women attributed their negative college experiences to: unsupportive and negative advisors; lack of guidance in selecting a course of study; and sexual harassment. In addition, the lack of women role models was “detrimental to their education” (Robinson & Reilly, 1993, p. 80).

However, face-to-face contact with a same gender role model may not be the only method that fosters a positive experience that could lead to increased persistence for women. Wolcott (2001) reported that an on-line resource, Women in Engineering Programs and Advocates Network (WEPAN), has proven successful. WEPAN pairs engineers working in industry with undergraduate women students. Discussions between students and mentors include the following topics: policy supporting work/family balance, financial advice, coursework, and the practicalities of a job in the engineering workforce. However, even by expanding networks outside academe to increase access to women role models, there remains a significant underrepresentation of women in STEM that needs attention (Wolcott, 2001).

Although much of the research supports the value of women role models, there are some who argue against its effectiveness. Griffith (2010) noted a higher rate of persistence in STEM majors by women who attended undergraduate institutions with an emphasis on both teaching and research. A higher number of women in graduate STEM majors had a positive effect on the retention of undergraduate women in STEM studies. But, the increased presence of women STEM faculty members appeared to have the
opposite effect. Griffith hypothesized this could be due to women holding positions that are lower in rank as compared to their men colleagues.

Valian (1998) takes a strong stance against the idea that successful women can serve as role models for others, calling the notion a “hoax” (p. 329). She states that instead of role models, women need to have suggestions of how they can do their best work and be recognized and rewarded. Instead of role models, she refers to women who can be “trailblazers,” stating that they can be “uplifting and inspirational,” demonstrating courage (Valian, 1998, p. 329). While some may argue this difference is just semantics, Valian argues that “observers often reason incorrectly from the example set by role models…Trailblazers also help us by showing that barriers to success are not completely insurmountable” (Valian, 1998, p. 329).

Bernice Sandler (n.d.b) also downplayed the role of a mentor. She suggested that the importance assigned to mentoring is based on flawed research. Sandler explains that often researchers ask individuals, who have had mentors, to define those they view as successful. These individuals, in turn, identify a mentor as someone they have had a strong professional relationship with, not a person who has been supportive such as a friend, colleague, or boss. In particular, Sandler found women do not describe a mentoring relationship as one in which “women assist women” (Sandler, n.d.b, para. 2). Sandler also asserts that it is difficult to determine other factors, besides mentoring, that may have assisted in an individual’s persistence and success.

**Chilly Climate**

Another aspect that has been found to affect women’s persistence is the chilly classroom climate. Despite overcoming many barriers that deprived women of an
education in the last 40 years much work is left to be done (Sandler, n.d.a). Sandler, a Senior Scholar in Residence at the National Association for Women in Education, stated many thought if the doors to educational opportunity were open, all would be equal—instead there are “still many hidden barriers, especially in the classroom” (Sandler, n.d.a, para.1). Hall and Sandler (1982) defined those hidden barriers as devaluation, sex-stereotyping, differing expectations, and harassment. They cited the following as examples of devaluation of young women: young men being called on more often than young women; instructors nodding and gesturing to young men when they speak versus looking elsewhere when young women talk; and the valuing of verbal assertiveness as positive in young men and not in young women.

Additionally, Hall and Sandler found young men received more feedback, praise, and criticism, while young women were more likely to be acknowledged that they had been heard. They also documented instructors asking young men open-ended questions, when young women were asked about facts; additionally, silence was viewed as a period in which young men were thinking about the question, but in the same situation, young women were viewed as shy or not knowing the answer. Hall and Sandler noted faculty, staff, and students can unknowingly participate in these behaviors. Even though the individual behaviors may be small, they reported that when they happen again and again, creating an atmosphere in which young women’s ambition, classroom participation, and self-confidence can be lessened.

**K-12 studies.** Silverman and Pritchard (1996) and Warrington and Younger (2000) noted many of the same barriers outlined by Sandler (n.d.a). For example, lack of equity in the classroom was recognized, despite young women seeming to enjoy the
technology curriculum and having confidence in their abilities (Silverman & Pritchard, 1996). Young women noticed that teachers called on young men more often and appeared to have less interest in their work (Silverman and Pritchard 1996). They also complained of young men’s behavior as an obstacle when trying to complete lab experiments or other enriching activities (Warrington & Younger, 2000).

While young women described being criticized by young men and stereotyped about their lack of technological skills (Silverman & Pritchard, 1996), Warrington and Younger (2000) noted teachers had sexist attitudes and low expectations for young women. Teachers believed young men had an intuitive sense about their work that enabled them to achieve at a higher rate than young women. An example of this was a teacher assisting a young man by explaining how to do an experiment, whereas when a woman asked for assistance, the teacher completed the experiment for her, leaving the young woman to watch (National Science Foundation, 2007). When discussing their findings with middle school teachers, Silverman and Pritchard (1996) found teachers had not considered how emerging sexism could influence their classroom climate. The teachers also admitted that they did not have strategies to deal with the sexist behaviors.

**Postsecondary studies.** Collins, Bayer, and Hirshfield (1996) found students experienced negative treatment in their engineering classrooms. Also, perceived “chilly” climate contributed to a classroom where women indicated faculty did not support women and men equally. In fact, four times as many first year and sophomore women, as compared to men, indicated lack of support (Collins et al., 1996). Wasburn and Miller (2006) conducted a case study in an effort to assist faculty in understanding factors that contributed to the attitudes, beliefs, and perceptions of Women in Technology members,
an undergraduate student organization. Their findings indicated a significant number of women felt isolated in their classes, and held the belief that professors did not treat women and men equally. Particularly challenging for women were group projects, with one woman commenting, “the men don’t want us to work with them on projects. When we do, they give us these stupid jobs to do. If we say anything, they look at each other, so I just stopped saying anything” (Wasburn & Miller, 2006, p. 70). Another poignant comment supporting the theme of isolation by a survey participant included, “I hate group projects. The guys don’t really want to work with me. Most of the professors don’t seem to care one way or the other. I think they’d all be happier if we just disappeared” (Wasburn & Miller, 2006, p. 70)

While Vaccaro (2010) argued that much has changed since the original studies of chilly climate by Hall and Sandler (1982), she acknowledged that “hostility, invisibility, and the feelings of being an outsider are still realities” for many college women (para. 1). For example, Vaccaro noted that micro-aggressions (“brief and commonplace daily verbal, behavioral, or environmental indignities whether intentional or unintentional” [Vacarro, 2010, para. 4]) are becoming more prevalent than more overt discrimination toward college women. In addition, Vacarro found women continued to be discouraged from considering traditionally male-dominated fields because others viewed them as too sensitive or weak. The Vacarro study underscores a fundamental problem—a significant number of women continue to feel unwelcome as social dynamics have not been improved by legislation or institutional policies.
Gender Studies and CTE

Despite the strides in gender equity since Title IX was enacted, CTE remains gender segregated, with little change in enrollment patterns since 1979 (Programs and Practices That Work, 2009; Women and Girls Still Missing, 2013). A joint project by The Association for Career and Technical Education, The National Alliance for Partnerships in Equity, The National Association of State Directors of Career Technical Education Consortium, and The National Women’s Law Center found that sex discrimination and sex-stereotyping can be linked to the lack of enrollment in nontraditional CTE courses (Programs and Practices That Work, 2009). Examples of discrimination included gender-based harassment, teachers inadvertently allowing young men to monopolize equipment, as well as steering young women away from programs nontraditional for their gender.

Although attention has been given to the recruitment of young women in STEM CTE programs nontraditional for their gender (Olson, 2013; Todd, 2013; Webber, 2012; White, 2002), there are few studies that examine retention. In postsecondary education, it is difficult to find programs defined as CTE. Because STEM CTE is found at the high school level in the areas of technology education and engineering, I chose to look for postsecondary studies in these areas. Studies on retention were few, exceptions included a qualitative study about the factors that influence the retention of women as technology education instructors (Haynie, 2003) and several studies exploring the experiences of women transferring from community colleges to 4-year institutions in STEM pathways (Packard, Gagnon, LaBell, Jeffers, & Lynn, 2011; Starobin & Laanan, 2008). Despite research in the area of recruitment and retention of young women in STEM, none of the
aforementioned researchers conducted studies of the retention of young women in a high school CTE environment.

A possible exception is a qualitative study conducted by Hyun (2014) on the perceptions of middle school young women in a robotics program (a program often found in high school CTE). Hyun found that the young women in the robotics program noted participation in the program as positive and rewarding. They believed that the curriculum could have real-life application and was a choice for them. However, because of the academic level of the program (middle school), it is uncertain if findings would be similar in a CTE robotics program.

I have only found one qualitative study regarding retention of young women in a nontraditional CTE high school program—a construction technology program in California. The study was completed by Brookman (2011) and focused on both students’ and staff’s perceptions of gender equity. Findings demonstrated both young women and staff believing the CTE program provided a gender-equitable environment with few reported instances of discrimination or harassment.

Additional findings included the perceived need for staff professional development in the areas of personalization of curriculum as well as tying the curriculum to existing careers. Suggested professional development included the use of female mentors, career exploration activities and internships designed to build self-efficacy in young women in fields non-traditional for their gender.

**Summary**

Despite the progress young women have made in STEM studies, barriers to equality remain. Stereotypes about men and women have been debunked by science, yet
are still perpetuated, affecting the opportunities young women have in STEM (National Coalition for Women & Girls in Education, 2012). Hill et al. (2010) noted that the transition between high school and college is a “critical moment” when many young women turn away from studies in STEM (p. 5). As such, learning more about young women who persist at this critical juncture can help educators more intentionally address the shortage of women in STEM.

The literature identified several factors that influence the retention of women in STEM, including self-efficacy in math and science and how stereotype-threat undermines the ability of young women to perform to the best of their ability in both math and science. In addition to self-efficacy and stereotype-threat, the lack of same gender role models may be another reason that there are so few women persisting in STEM. Seeing women in STEM fields allows young women to picture themselves as scientists or engineers, helping them to set goals for a future in STEM (Blickenstaff, 2005; Britner & Pajares 2006; Jones, 2010; Mitchell & Hoff, 2006; Programs and Practices That Work, 2009). Chilly climate was also found to have an effect on the retention of young women in STEM. Whether chilly climate is fostered by overt actions or a lack of knowledge about inclusive and gender equitable practices, the retention of women in STEM is affected. It is imperative that research on retention continues to take place. In particular, research like my study is needed to identify factors that influence the retention of young women in general and specifically in programs that have a mission to increase women’s participation such as secondary CTE programs.
Chapter 3 will outline my research design, including data collection and analysis methods. I will also discuss my role as researcher-as-instrument and techniques I will employ to enhance the trustworthiness of the research.
CHAPTER 3: METHODOLOGY AND RESEARCH DESIGN

Introduction

This chapter details how I explored the reasons young women either stay or leave a STEM CTE program of study. In particular, the overarching research question, *What influences young women to re-enroll or leave STEM CTE programs of study for another academic year at one CTE school in a small Midwest city?* guided the data collection.

Chapter 3 outlines the qualitative research methodology, setting of the study, selection of participants, data collection, data analysis, researcher’s role and positionality, trustworthiness, and limitations of the study.

Methodology

Stake (2010) describes qualitative researchers’ roles as personal instead of impersonal, with researchers desiring to understand rather than explain a phenomenon. Their aim is “knowledge production or toward assisting practice or policy development” (Stake, 2010, p. 16). Qualitative research is interpretive, experiential, situational, and triangulated (Stake, 2010). It occurs in a natural setting with the researcher as the instrument (Creswell, 2009; Stake 2010). Typically included in a qualitative research design are multiple sources of data, inductive and/or deductive data analysis, participants’ meanings, emergent design, a theoretical and/or conceptual lens, interpretation, and a holistic account in which the qualitative researcher renders a larger picture defined from multiple perspectives (Creswell, 2009).

Case Study

A case study allows the researcher to study a phenomenon within its own context using a variety of data sources (Baxter & Jack, 2008). A general case study is like a
funnel—researchers cast a wide net scouting for possible places and people that could be sources of data, then determine the feasibility of the data and site for their purposes (Bogdan & Biklen, 2007). Case studies consist of research in which the investigator “explores in depth a program, event, activity, process, of one or more individuals” (Creswell, 2009, p. 13). Case studies allow the reader to better understand a phenomenon by presenting the findings in a manner in which the reader naturally experiences it (Lincoln & Guba, 1985).

Yin (2014) states that a single case study design is justified under certain circumstances—“where a case represents (a) a critical test of an existing theory, (b) a rare or unique circumstance, or (c) a representative or typical case, or where the case serves a (d) revelatory or (e) longitudinal purpose (p. 52).” A unique case study is one in which each single case is worth documenting and analyzing (Yin, 2014). My case study falls into this category. Each young woman’s experience in a STEM CTE program served as a case and should be studied, as it may help in understanding why young women decide to stay or leave STEM CTE programs of study.

**Setting**

The unique cases are embedded in a particular setting. The setting of my research is an area career and technical center (CTC) in a small Midwest city. The city has a population of approximately 108,000 residents and is home to one state university, two colleges, and three satellite college campuses. The CTC is part of the Winter Valley Public School (WVPS) District (pseudonym to further protect the identity of the participants). The school district has approximately 18,000 students, with roughly 5,100 students registered in grades 9-12.
All WVPS students, as well as students from county-sending schools (two county
high schools, private and parochial schools, as well as home schooled students), are able
to enroll in entry level CTE classes offered on WVPS high school campuses or at the
CTC. Advanced CTE classes as well as entry level CTE programs with high-end labs are
located only on the CTC campus.

At the time of the study, approximately 2,000 students (792 of whom were young
women) were enrolled in CTE classes throughout all WVPS District campuses. Of the
young women enrolled in CTE classes, 102 were in grade 9, 228 in grade 10, 189 in
grade 11, and 273 in grade 12. These enrollment numbers reflected the population of
young women in STEM CTE and non-STEM CTE programs.

Student courses at CTC span 21 program areas. The program areas include
traditional vocational offerings (e.g., certified welding, automotive technology,
construction technology, and culinary arts), as well as courses not generally seen in a
high school CTE center (e.g., laser technology, photonics, geospatial technology, civil
engineering, and laboratory technology). The majority of courses offered at CTC are
STEM courses. The focus on STEM has been the result of previous CTC directors’
visions.³

WVPS District prides itself on innovation and preparation of its students for the
21st century workforce. The district has demonstrated its support of STEM by having a
designated STEM elementary school; PLTW curriculum expanded to the elementary and
middle schools; and a STEAM (Science, Technology, Engineering, Arts, and Math) bus,

³ To protect the confidentiality of the study’s participants, a citation has not been provided.
equipped with work stations that allow elementary students to perform hands-on activities related to STEAM. The STEAM bus travels to all elementary schools.

Participants

In a qualitative study, purposeful sampling is often used because a researcher intentionally selects individuals and sites to understand a central phenomenon (Creswell, 2008). To answer the question of what influences the retention of young women in STEM CTE, I invited young women who were in their first year of a STEM CTE program of study to participate in my study. In particular, I looked for young women who were enrolled for the first time in CTC’s STEM CTE courses: A+IT Essentials, AP Computer Science A, C++ Computer Programming, Computer Aided Drafting (CAD), Geospatial Technology, Information Technology, PLTW Civil Engineering and Architecture, PLTW Introduction to Computer Science, PLTW Digital Electronics, PLTW Introduction to Engineering Design, PLTW Robotics and Computer Integrated Manufacturing, Laser Technology, and Photonics. Although life sciences are considered part of STEM, for the purpose of this study only CTE program areas that have a basis in physics/chemistry, computer programming, and engineering were selected. My reasoning for including young women only enrolled in these areas was based on the fact that women still lag behind men in postsecondary enrollment and the workforce in these fields (Hill et al., 2010).

After receiving IRB approval in the summer of 2015, as well as permission from WVPS District, I began my study. In my role as a CTC administrator, I viewed STEM CTE class lists searching for enrollees who were young women. The total student enrollment for STEM classes located on the CTC campus was 325, of which 29 were
young women. Photonics was the only program with no young women enrolled. Of the 29 young women enrolled in STEM CTE, 17 were seniors and were eliminated as participants due to their inability to enroll for STEM CTE classes the following school year.

I invited 12 young women early spring semester 2016 (all were students on the CTC campus) to participate in my study. Each young women and their parent were sent an invitation via email (Appendix A), a child assent form (Appendix B), and a parent consent form (Appendix C). Of the 12 young women invited to participate in the study, eight agreed and signed the child assent form and their parents signed the parent consent form.

Data Collection

Data are the “rough materials researchers collect from the world they are studying: data are the particulars that form the basis of analysis” (Bogdan & Biklen, 2007, p. 117). The type of data collected is dependent on the research question as well as the style of inquiry (Stake, 2010). Because I was interested in classroom structures and young women’s self-efficacy in STEM, I collected data from student interviews, classroom observations, and student transcripts.

I began collecting data early in January 2016, first collecting data by conducting classroom observations. I interviewed students in February 2016. The interviews occurred in close proximity to enrollment for the following school year. Additionally, I collected participants’ classroom grades and test scores. I was interested in viewing grades and test scores as well as hearing participants’ perceptions of their abilities.
For data storage, I titled all of the participants’ observational data, artifacts, and interview transcripts using a pseudonym chosen by the participant. I shredded written field notes after I scanned them as digital files. All data were stored on a password protected computer and will be given to my advisor at the conclusion of my study to store for 7 years as required by campus IRB.

**Observations**

I collected observational data in the STEM CTE classrooms where participants were enrolled as students. I observed six (three students were in a class together and observed at the same time) 90 minute classes, making a point of being in the classroom at the beginning and ending of the period, as these are times students are free to have informal conversations with their classmates as well as their instructor. Students and instructors are accustomed to visitors (other instructors, administrators, as well as touring groups) in their classroom, therefore my entrance into the classroom and seated observation was not an unusual occurrence. During the times I was in the classroom, I was a complete observer, which is a role the researcher assumes when planning not to participate in the classroom proceedings (Creswell, 2009).

As a “complete observer,” I took detailed field notes—“the written account of what the researcher hears, sees, experiences, and thinks in the course of collecting and reflecting on the data in a qualitative study” (Bogdan & Biklen, 2007, pp. 118-119). I used an observation protocol (Appendix D) that allowed me to note the physical setting of the class, description of the participants, activities, and individuals engaged in the activity, as well as participants’ comments. Also included in the observation protocol was a column where I jotted down reflective comments, questions, observations of
nonverbal behaviors, as well as my interpretations of events. I payed particular attention

to topics noted by Hall and Sandler (1982) and Vaccaro (2010) related to “chilly
classroom climate,” as well as any instance in which a young women indicated that she
was less capable than a young man in being able to successfully complete a task
(stereotype-threat).

Artifacts

Participant grades and test scores served as artifact data. I was interested in
comparing student grades to the students’ reported beliefs that they could achieve success
in the next level of the course. These data were important in light of studies that found
that young women often perform equally well in math and science, but have a lower
opinion of their capabilities when compared to young men (Bandura, 1997; Linver &
Davis-Kean, 2005; Lupart et al., 2004).

Interviews

I conducted one semi-structured interview with each participant. The interview
protocol (Appendix E) was based on questions used by Zeldin and Pajares (2000) in their
interviews focused on women’s self-efficacy beliefs in math, science, and technology. I
added questions to address classroom structures that may intentional or unintentionally
promote chilly classroom climate. Also, I occasionally deviated from the interview
protocol to clarify some of the answers participants gave to assist me in identifying
classroom structures or interactions that may have influenced the young women’s
classroom experience. Students (seniors) who were not eligible to participate in the study
piloted the interview questions to ensure the clarity and purpose of each question. All of
the students who piloted the protocol were currently enrolled in a STEM CTE course.
At the beginning of each interview, I engaged the students in casual conversation about my study to increase their comfort level. I read a statement about confidentiality as well as a scripted synopsis regarding the purpose of the study to each student. I began each interview asking basic demographic questions as well as general questions about their STEM CTE class, which allowed me to establish rapport with the participant. Questions pertaining to participants’ self-efficacy beliefs focused on their experiences in math and science, beliefs about their math and science ability, as well as their view about the difficulty of their STEM CTE class. Interview questions related to liberal feminist theory included asking participants to describe their relationship with their classroom instructor and the young men in their class, as well as a reflection on classroom experiences they wished they could change and a memorable classroom event. At the close of the interview, I asked each young woman to choose a pseudonym to be used for data storage and reporting.

Interviews lasted approximately 45 minutes and were conducted in the CTC conference room or in my office when the conference room was unavailable. During the interview, I took notes that included my observation of nonverbal behaviors, my interpretations, questions, and reflective comments. The interviews were recorded and then transcribed with permission of each participant. Each participant was given a copy of the transcribed interview and asked to advise me of corrections. Two participants advised me of corrections which were related to grammar mistakes.

**Data Analysis**

Once data are collected, it is important for the researcher to look for patterns of behavior, participants’ common thoughts and phrases, as well as events that are seen as
important (Bogdan & Biklen, 2007). Coding is common in research—it consists of identifying topics, themes, and issues important to the study (Stake, 2010). For this study, I coded observation field notes, interview transcripts, personal reflections taken throughout the research process, tangible documents, and artifacts.

Creswell (2009) categorizes three types of coding: codes developed only on emerging information (inductive analysis); predetermined codes in which the data fit (deductive analysis); and a combination of the two aforementioned approaches. I used a combination of codes, relying on inductive and deductive analyses. To assist with identifying these codes, I developed a codebook (Appendix F). Saldana (2009) suggested that researchers keep a record of emergent codes because codes can accumulate quickly as analysis progresses. He suggested that “a compilation of the codes, their content descriptions, and a brief data example for reference” be kept in the codebook (Saldana, 2009, p. 21). The development of the codebook was an on-going process. I also followed the advice of Auerbach and Silverstein (2003) and kept a copy of my research purpose, theoretical and conceptual frameworks, and research question at the table at which I worked to keep me focused when making coding decisions.

The codebook contained codes based on my theoretical lens and conceptual framework. The codes reflecting my theoretical lens of liberal feminism were based on work by Hall and Sandler (1982). Hall and Sandler noted many instances in which college women felt devalued in the classroom. These instances included: the number of times young women were called on in class as compared to young men; conversations young women had with their instructors; young women being criticized regarding their
lack of skill in the subject matter; and teachers doing the work for young women versus coaching them through a process.

I used predetermined codes based on my conceptual framework of self-efficacy. These codes included young women’s belief about their math and science abilities, instances in which young women increased their self-efficacy beliefs through mastery experiences and vicarious experiences, as well as tasks in which they expressed confidence and were willing to try new activities.

After reading through each participant’s transcribed interview, field notes, and artifacts, I placed the documents in an Excel spreadsheet, making notes next to the data that I considered most salient. I then reviewed the notes and coded the data line-by-line, keeping in mind my predetermined codes as well as being cognizant of any emergent codes. I used Excel to sort the codes and I looked for common themes across cases. The cross-case analysis assisted in identifying broad themes—these themes included role models, perception of ability and perseverance, relationships, and roadblocks. Further analysis of the data led to identification of a collection of subcategories.

**Researcher’s Role and Positionality**

Within the context of this study, I classify myself as a constructionist. Crotty (1998) asserts that constructionists view the creation of meaning based upon how individuals engage with the world. Individuals’ interpretations of events are relative, based on their perspective (Baxter & Jack, 2008). My primary purpose as a researcher was to record with as much accuracy as possible the young women’s view of classroom structures and their own self-efficacy beliefs. Because I am the instrument of research, I must remain aware of how my views shape the research process. In this study, I
acknowledge that my view may differ from the young women I observed and interviewed.

In addition to identifying my epistemological approach, it is important that I identify my position in the organization in which I am conducting the study. I am a White woman CTC assistant director who has worked at the CTC for 10 years. My two major job functions are: instructional leader and manager. Instructional leadership tasks include observing classrooms and working with instructors to identify best practices. As a manager, I am responsible for developing a master schedule of classes, reporting state data, and managing the CTC transportation system. My interaction with students occurs during classroom observations, casual conversations in the hallway, and discipline referrals. Discipline referrals are relatively few because most students choose to attend the CTC primarily because of their career interests.

Because of my role as an assistant director, I have intimate knowledge of the CTC. As a researcher, I am operating from the perspective of a practicing educator with 33 years in the field as a history teacher, counselor, and administrator. In addition to working in the public school system, I have worked in a Women’s Center that offered services to survivors of domestic abuse and sexual assault. The center operated with a feminist philosophy. My 8 years as a volunteer, staff member, and board member at the Women’s Center has influenced my feminist positionality and the way I view the world.

**Researcher Trustworthiness**

Lincoln and Guba (1985) stress the importance of trustworthiness in a research study. They state that trustworthiness involves establishing: credibility, transferability,
dependability, and confirmability. Additionally, they emphasize the importance of resilience. I will address each of these in the sections that follow.

**Credibility**

Qualitative researchers triangulate their data to ensure dependability and credibility of their findings (Lincoln & Guba, 1985; Stake, 2010). Observing participants in the classroom enabled me to collect data that might not have emerged in an interview. It allowed me to see if there was a pattern of consistency between what I observed and the statements young women made during the interview. In addition to observations and interviews, I reviewed each participant’s academic transcript, which included their grades and test scores. My purpose in collecting all of the aforementioned data was to ensure the trustworthiness of my findings and interpretations.

**Transferability**

I used a thick descriptive narrative as I presented the findings. The narrative allowed me to achieve credibility in drawing conclusions that others may find transferable to other young women in STEM CTE classrooms.

**Dependability**

Creswell (2009) defines peer debriefing as a technique that is used to “enhance the accuracy of the account” (p. 192). I asked the CTC literacy specialist and CTC counselor to read my findings and interpretations so that any inherent-biases could be mitigated. Each individual is familiar with CTE, having at least 9 years in the field. I asked that they read my study looking for any statements that might indicate inherent-bias. After each individual read my study, they indicated that my research did not contain any biases.
I also utilized member-checking with each participant in my study by giving them a copy of the interview transcript and asking them to read it for accuracy. Two members of the study cited minor corrections consisting of grammar errors.

**Confirmability**

Lincoln and Guba (1985) refer to confirmability as the ability of the researcher to maintain a degree of neutrality, so that the research findings are reflective of the respondents’ experiences and not shaped by the researchers bias, motivation, or interest. To establish confirmability, I triangulated the data, utilized colleagues to read my study and report any inherent-bias, as well as self-disclosed my positionality in the study.

**Reflexivity**

Lincoln and Guba (1985) note that one final step to enhance trustworthiness is to keep a reflexive journal. The reflexive journal is a kind a diary documenting judgment calls the researcher makes. The diary can be kept on a daily basis or as needed, with entries about “self (hence the term ‘reflexive’) and method” (Lincoln & Guba, 1985, p. 327). The journal provides a place where the researcher can record methodological decisions made and the reasons for making them—information which is of great assistance to the auditors if they believe inherent-bias has been found in the methodology (Lincoln & Guba, 1985). I kept a reflexive journal throughout the research process for these reasons.

**Limitations of the Study**

In a case study, the researcher makes decisions regarding the data to be collected (Creswell, 2008). Potential limitations to my study included the students’ recall and self-
reporting of their experiences in their STEM CTE course, my role in the organization, and possible negative perceptions by students and parents of CTE.

Students were interviewed near the start of second semester. They were asked questions about experiences that occurred throughout the school year. The time span between their entry into the course and the interview date may have influenced the recall capabilities of some participants.

Many of the participants in the study may recognize me and be familiar with my role as an assistant director at the CTC. My job could have had an adverse influence on the willingness of students’ full participation, as well as their honesty in answering questions during the interview process. It also could have hindered the naturalness of the daily classroom operation during classroom observations, as instructors recognize me as a supervisor and many students see me in a role of authority.

Each student was observed once during a 90 minute class period. Additional observations may have resulted in more nuanced findings and may have assisted me in identifying additional barriers the young women faced or instances of support that helped to encourage the young women to re-enroll in another STEM CTE course.

The 2006 reauthorization of the Carl D. Perkins Act called for vocational education to be renamed career and technical education (Carl D. Perkins Career and Technical Education Improvement Act of 2006). Despite this renaming, some students and parents may view CTE in the same way vocational education was perceived—as education for those students not college bound. This misperception of CTE may dissuade students from enrolling in STEM CTE as well as a lack of parental encouragement to enroll in a STEM CTE course, which may have limited my participant pool.
Summary

Using an embedded multiple case study research design, I collected interview and observational data as well as academic artifacts from young women participating in STEM CTE program areas. I interviewed eight young women in four STEM CTE program areas.

The conceptual framework of self-efficacy, as well as my theoretical framework of liberal feminism shaped the deductive analysis used to examine and code the data. In addition, I also used inductive analysis to develop findings. Following the elements of researcher trustworthiness, as defined by Lincoln and Guba (1985), assisted me with the integrity of my study.

In the next chapter, Research Findings, I introduce the cases and common themes found across participants. The themes were determined from observation field notes, participant academic artifacts, interview transcripts and my personal journal.
CHAPTER 4: RESEARCH FINDINGS

If we’re going to out-innovate and out-educate the rest of the world, then we have to open doors to everyone. We need all hands on deck. And that means clearing hurdles for women and girls as they navigate careers in science, technology, engineering and math.

First Lady Michelle Obama
September 2011
(White House Blog, 2011)

Introduction

The purpose of my study was to examine factors that influence young women’s decisions to remain in a STEM CTE program of study. I framed my study with an overarching question: What influences young women to re-enroll or leave STEM CTE programs of study for another academic year at one CTE school in a small Midwest city?

I invited 12 young women to participate in my study. Of the 12, 8 elected to participate. The eight students were enrolled in grades 9-11 at Rockledge High School which is adjacent to the CTC. The young women were enrolled in their first STEM CTE courses—C++ Programming, PLTW Intro to Computer Science, PLTW Introduction to Engineering Design, and PLTW Digital Electronics.

I observed each of the eight young women during a 90 minute class period and later interviewed each one individually. I also used test scores and course grades in math and science, as well as in their STEM CTE course to triangulate the data. Each young woman was a single case, with the themes developed using cross-case analysis. Below, I first introduce each participant case and then outline the salient themes that emerged from the interviews and classroom observations: role models, perception of ability and perseverance, relationships, and road blocks.
Study Participants

The eight participants, all students at Rockledge High School (the high school adjacent to the CTC), were:

Alexandria. Alexandria’s father is a university engineering professor, and her mother is a liberal arts college graduate and currently works in the home. Alexandria has an older brother who has taken STEM CTE courses and is pursuing postsecondary studies in STEM. Alexandria expressed her willingness to answer my questions as well as her displeasure about her mother constantly “nagging” her to take STEM classes—in which she had no interest. She said that she finally succumbed to the “nagging” and signed up for her current course, in which she has little interest.

During my observation of Alexandria’s classroom, I noted that it was the noisiest of all classrooms I had observed. It was “controlled chaos”—several of the young men were out of their seats conferring with other students. These conversations were responsible for the noisiness. Despite this, everyone appeared on task and the conversations that I overheard were on topic. When Alexandria entered the classroom, she quickly signed on to her computer to check out the news on the Rockledge website. The only young woman in the classroom, Alexandria, nonetheless, appeared to comfortably converse with her classmates, particularly on non-classroom related subjects, including an upcoming field trip for another course. At the end of class the students were asked about the progress they had made, and Alexandria replied to the young man seated next to her, “I’ve been working on this all class and have gotten nowhere.”

Lard Flames (LF). A bit of an unusual pseudonym, but I believe LF prides herself in having a quirky sense of humor. Her ability to enthusiastically express her
opinions and experiences was far from what I expected, given my observation of her in
the classroom. At that time, LF spoke in a barely audible tone when addressing her
instructor; she sat alone and had no conversation with other students.

Despite her quietness in the classroom, it appeared that at least one student was
aware of LF’s ability and knowledge in STEM. This student, a young man I sat by
during my classroom observation, conversed with me about what he was working on and
acknowledged, without being asked, that LF was ahead of the rest of the class and was
very smart.

During the interview, LF spoke about her friend group who is interested in STEM
and also talked with admiration and pride of her mother who is in the medical field. She
seemed very self-motivated as she closed our interview by describing an internship she
hopes to complete over the summer in a postsecondary science lab.

Lisa. Lisa is the daughter of parents employed in science careers and has a
brother who is pursuing a college degree in a STEM field. Lisa reported that her parents
have encouraged her to do her best and to choose a career in which she is interested.
Another source of inspiration is her grandmother, who has been on expeditions to the
South Pole for a scientific technology company at which she is currently employed. Her
grandmother has traveled the world, and Lisa described her as having an adventurous
spirit. Despite her grandmother’s science experience, Lisa reported that her grandmother
seldom talks about science with her, she instead shares photographs of her many
adventures. Lisa said she can tell her grandmother takes great pride in the pictures she
has taken, and it is obvious that Lisa is pleased that her grandmother takes time to share
the pictures.
At CTC, Lisa has a quiet unassuming personality despite her academic talent in both math and science. Navigating a classroom of young men under the direction of Mr. Hall, Lisa was clearly a respected member of the group. Young men listened when she offered constructive feedback, and the young man who was her project partner deferred to Lisa when they were asked by Mr. Hall to describe their progress. Although soft spoken and seemingly serious for most of the class, Lisa smiled, joked with classmates, and appeared to feel comfortable in her surroundings.

**Mia.** When I met Mia, she exuded a gentle and friendly spirit. The daughter of an engineer and a marketer, Mia’s two brothers have pursued engineering in college; she has grown up in a home that encourages studies in science and mathematics. But she made it clear that her parents also support her in whatever career choice she plans to pursue—which currently is a career in ministry. When talking about her math and science experiences in school, Mia reported that her two favorite teachers in middle school were math and science instructors. Despite her fondness for these teachers, she reported that math was challenging for her.

Although not the only young woman in her STEM CTE class, Mia said that she was somewhat taken aback when she entered the classroom and found that the class was mostly populated by young men. When I conducted my observation in Mia’s classroom, she quietly worked the entire class period, rarely talking to the students next to her. She used the computer program as well as the models found in the classroom to work on her assignment. Mia stated that she has enjoyed the class, but her plans (formulated before she entered the class) include a class in a non-STEM area next year at the CTC. This is an area that her sister has pursued as a career.
**Rowan 1.** Rowan 1 is one of two students who chose the pseudonym Rowan, therefore, she is tagged Rowan 1 and the other student Rowan 2. Rowan 1’s father is in the programming field (currently unemployed), and her mother holds a job in healthcare. Rowan 1 is a PLTW student and is the only young woman in her class; she reported that the course has been difficult.

During my observation, she appeared very aware of her instructor’s whereabouts as he made his rounds, checking on student progress. Each time the instructor would approach Rowan 1, she would revert from writing in her notebook to make sure her programming page was on her computer screen. The screen displayed the same line of code on it each time the instructor walked by. There was a seat between Rowan 1 and the young man in the next occupied seat in the row. No conversation took place between the two until the end of the class when they stood by the door waiting to be dismissed. Rowan 1 rarely looked up during class, and her face was draped in her hair as if to hide the discomfort she was feeling.

After the students left the class, Rowan 1’s instructor approached me to talk. I expressed concern to the instructor about Rowan 1’s lack of progress. The instructor said he had tried to assist Rowan 1 in the past but had met with resistance; he was, therefore, hesitant to offer help again. The instructor also said he had contacted Rowan 1’s parent and found there had been issues at home, which he felt could have affected Rowan 1’s progress.

**Rowan 2.** Rowan 2 hails from a family of scientists and engineers. She is the participant who, in a quiet confident manner, is the most self-assured of her science and mathematical ability. The advanced math and science classes she is taking, and her
grades in these courses, support her claim that these subjects “come easy” for her. She has taken advantage of extracurricular activities that support her STEM studies and plans to continue in the STEM CTE courses in her current program.

Despite Rowan 2’s quiet demeanor, she spoke somewhat heatedly about young men leaving her out of a conversation in which she felt she was most likely more educated than them. She said this in a matter-of-fact way without a hint of self-aggrandizing. In her STEM CTE classroom, she worked quietly at a pace that kept her on target to complete her task on time. She also demonstrated a wry sense of humor, stating that both Mr. Brown and the young men in class frequently make bad puns.

**Tegan.** Tegan is the daughter of science professors at the university located in the same city as her high school and the CTC. Tegan talked about her mother’s career with great pride, explaining in detail the research she is currently conducting. Tegan’s mother’s success seemed to have clearly affected Tegan. Tegan is perky, self-assured, and made it very clear that she made her own decisions and was not swayed by friends’ course choices. Tegan said she was used to being one of the few young women in class, as had been the case in middle school technology classes, as well as in the extracurricular technology club she belongs to at Rockledge HS.

Tegan said she enjoyed being the only young woman in class, as she is much more competitive in that environment. In her classroom, Tegan sat near the back and on the end of a row. She appeared to have a good relationship with the young man next to her as she joked and smiled often when conversing with him. Tegan reported that “Brown” (as she called her instructor fondly) was very enthusiastic the first day she met him. His enthusiasm persuaded her to take his class instead of another STEM CTE class.
Mr. Brown’s classroom relationship with Tegan appeared to influence Tegan, as she talked about her plans to take the next course in the program sequence.

**Willow.** Willow is the oldest child in her family; she has one younger brother. Her mother is a business owner, and her father works in IT. Willow’s first exposure to STEM was in a middle school technology class, during which she enjoyed using Inventor, a computer aided design software program. Because she liked Inventor so much, she introduced her younger brother to the software. Willow’s and her brother’s interest in Inventor influenced their parents to purchase a version for them to use at home.

Willow planned her high school studies with a career of engineering in mind, but of late she has decided to pursue a career in astronomy, stating, “I want to be Carl Sagan.” While Willow gave the impression, during the classroom observation, of being a quiet demure student, she was one of the more vocal participants regarding her career plans and the way her parents have supported her. She stated that her parents told her that her choice to do “STEM stuff is fine. You don’t want Barbie dolls—great!” Willow then spoke about stereotyping and asserted that girls should be introduced to STEM at a young age.

**Findings**

I coded the data deductively and inductively which led to the development of four themes. I developed predetermined codes based on my conceptual framework—self-efficacy, and my theoretical lens—liberal feminism. While coding the data, I was cognizant of my predetermined codes as well as codes that emerged as I analyzed the data. After reviewing the coded data, I identified the following themes: role models,
perception of ability and perseverance, relationships, and roadblocks. The remainder of this chapter will discuss these themes.

**Role Models**

All of the young women had either parents or other relatives who were working or had worked in the STEM field, all influenced them and served as role models. Many of the young women spoke about the roles these individuals played in their lives. For example, although Lisa’s grandmother never spoke directly of science, Lisa was acutely aware of the science company for which her grandmother worked and took deep interest in her expeditions to the South Pole. Lisa said she knew her grandmother took great pride in her photography, and that it was through these pictures that they shared a love of adventure and science.

Like Lisa, all of the other participants had parents who were either employed or had been employed in IT, engineering, science, or the medical field; and, with one exception, Alexandria, the participants felt positive encouragement to study math and science. In fact, most of the young women lived with two parents working in the STEM field. Tegan’s and Rowan 2’s parents, for instance, are biologists, either teaching or researching at the local university.

All participants had parents who encouraged them to study STEM. Despite this, two participants in my study chose different career paths. Even though Alexandria’s mother “nagged” her to take an engineering course, her parents agreed to encourage her pursuit of coursework in journalism after her trial run in engineering. Although Mia did not have the pressure Alexandria experienced from her mother, she grew up in a family with a father and two brothers in engineering. Despite this, Mia, with support from her
parents, has decided on a career in the ministry and does not intend to pursue additional classes in STEM CTE.

Both Tegan and LF expressed very strong admiration of their mothers, one a scientist studying muscle stem cells and the other a medical doctor. Tegan described her mother as “pretty famous” because of her work to constitute muscle fibers in a specific manner. Tegan stated that she had witnessed a love of science from her mother as well as members of her mother’s lab. She enjoyed going to her mother’s lab—a lab that she described the individuals “being very close.” Tegan spoke of float trips and Christmas parties throughout the years with members of her mother’s lab. The introduction to women in nontraditional careers may have contributed to Tegan’s independent spirit and self-confidence to forge a career path in science, even if her friends decided on a different pathway.

LF described her mother as “very analytical, thorough, and very, very intelligent.” She stated that she looked up to “her highly.” It was evident by LF’s tone and expression that the affection and admiration she felt for her mother was genuine. The source of this admiration may be due to LF’s high expectations for herself, her love of science, the craving she had to take as much science coursework as possible, and her desire for a career in material science.

Familial role modeling influences were not limited to parents in the STEM field; the young women talked about other relatives in STEM careers. Tegan has an uncle who worked for Intel, as well as a sister who Tegan described as being a “successful programmer.” Mia’s brothers majored in engineering in college, while Lisa’s brother
plans to major in an engineering-related field. Rowan 2 represented the third generation in her family who planned a career in engineering.

Although family role models were important in the young women’s lives, role model influences extended beyond the family. Mia, Willow, and Tegan spoke of science programs they attended at the local university. In particular, Willow mentioned attending a Saturday Morning Science presentation in which a woman spoke about her research and the struggles she had and overcame in establishing her career in astronomy. This, plus the encouragement she received from her parents, were factors that set Willow’s career path on a trajectory toward astronomy.

It was apparent in my study that all the young women had role models, both men and women, whom they admired. Even Rowan 1, whose father was currently unemployed, spoke of his encouragement to “take classes that were out of the ordinary.” This admiration and exposure to STEM may have influenced their choice in school course work as well as a future career.

**Perception of Ability and Perseverance**

Many of the young women in my study had a modest view of their ability. Despite this, they had the drive to continue with the next academic course in math and science. The young women who indicated an interest in STEM also signed up for the next course in their STEM CTE program of study. In this portion of the findings, I will describe how the young women in my study have persevered despite many of them underestimating their ability related to math, science, and STEM CTE studies.

All of the young women in the study, with the exception of Rowan 1, were at an advanced level in their mathematics and science coursework. Rowan 1 stated:
I am not good in math. I try. I mean it’s just that my mind works in a very poetic way I suppose, and math doesn’t really allow me to use any creativity. I’m still able to understand it pretty well.

When asked if she was willing to share her math and science grades, Rowan 1 responded that she did not “feel the need to discuss my grades.” Because I had access to the students’ grades as part of this study, I learned that Rowan 1’s MAP test scores (advanced level in mathematics; proficient level in science) supported ability in math and science, her math, science, and STEM CTE course grades were in the “C” range. Despite this, Rowan 1 decided to persist in math and science—she has signed up for Geometry, Honors Biology, as well as an upper level PLTW course for the following school year.

Of the remaining young women, several commented that they worked hard for their grades. Lisa said, “I’ve usually been pretty good in math up until this year. In Calc, I like it all right, but it’s not my favorite thing to do.” Despite Tegan’s self-confidence in her STEM CTE class, she reported that she has to work hard to do well in math, but felt that her science ability was “very proficient.”

In addition to commenting about working hard for their grades, the young women often understated their ability as measured by their test scores and course grades. LF described herself as “marginally competent” in math and science, despite earning As both semesters in her advanced math and science courses. Alexandria said she had a “pretty good grasp” of the concepts in math and science, while Willow chuckled that her science ability was stronger than her ability in math. Mia felt her grades in math and science were higher than “what I thought my ability was in these subjects.” Despite having As in advanced math and science, Rowan 2 stated that she was only “pretty good in math and
science.” However, her voiced opinion of her abilities was stronger than the others’ when she shared that she does not “ever really have to study for math tests.”

<table>
<thead>
<tr>
<th>Participant</th>
<th>Math Class</th>
<th>Math Semester Grades</th>
<th>Science Class</th>
<th>Science Semester Grades</th>
<th>7th Grade Math MAP Level/ Scaled Score</th>
<th>8th Grade Science MAP Level/ Scaled Score</th>
<th>ACT Math/Science Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexandria</td>
<td>Pre-Calc Honors</td>
<td>A/A</td>
<td>Biology Honors</td>
<td>A/A A/A</td>
<td>Advanced</td>
<td>Advanced</td>
<td>--</td>
</tr>
<tr>
<td>LF</td>
<td>AP Calculus BC</td>
<td>A/A</td>
<td>Honors Chemistry</td>
<td>A/A A/A</td>
<td>-- --</td>
<td>31/31</td>
<td></td>
</tr>
<tr>
<td>Lisa</td>
<td>AP Calculus BC</td>
<td>B+/B</td>
<td>Honors Chemistry</td>
<td>A/A A/A</td>
<td>Advanced</td>
<td>Advanced</td>
<td>31/27</td>
</tr>
<tr>
<td>Mia</td>
<td>Geometry Honors</td>
<td>B-/B</td>
<td>Biology Honors</td>
<td>B+/B A-/A-</td>
<td>Proficient</td>
<td>--</td>
<td>699</td>
</tr>
<tr>
<td>Rowan 1</td>
<td>Algebra 1 Honors</td>
<td>--/C-</td>
<td>Physics Chemistry</td>
<td>C+/C- C-/C+</td>
<td>Advanced</td>
<td>--</td>
<td>724</td>
</tr>
<tr>
<td>Rowan 2</td>
<td>Algebra 2 Geometry</td>
<td>A/A</td>
<td>Honors Physics</td>
<td>A/A A/A</td>
<td>--</td>
<td>752</td>
<td>30/28</td>
</tr>
<tr>
<td>Tegan</td>
<td>Geometry Honors</td>
<td>B-/C+</td>
<td>Honors Physics</td>
<td>A/B B+/A</td>
<td>Proficient</td>
<td>Advanced</td>
<td>703</td>
</tr>
<tr>
<td>Willow</td>
<td>Honors</td>
<td>A/A</td>
<td>Honors</td>
<td>A/A A/A</td>
<td>Advanced</td>
<td>Advanced</td>
<td>749</td>
</tr>
</tbody>
</table>

*Note.* Some test scores were unavailable.

The majority of young women in my study described their collective ability as lower than evidenced by their grades. Many of the young women voiced the necessity of “having to work hard” and the view that they performed “pretty good” in math and science was voiced by the majority of the young women.

Viewing their ability as less than evidenced by test scores and grades may originate from the young women’s view of what it “looks like” to be successful in math and science. Tegan stated that to be successful, a student first needed to learn the theories behind what she is learning. Lisa said, “you have to be good at memorizing little simple
things” and then you need to have the ability to “put things together in your head and use
general logic to get the answers instead of memorizing all the equations.”

Alexandria and Rowan 1 described their view of success in similar ways.
Alexandria said, “If you understand the content in both subjects and you are able to apply
that knowledge to related problems, that’s an indicator that you’ve learned something.”
Rowan 1 explained that if you are successful in math and science you can both “do and
understand what the teacher is saying. You can understand it written on a worksheet, and
you are able to teach others the same thing and have them understand it.” LF shared that
“a successful student has the foundations and knows how to approach the problem.”
Despite describing themselves as “marginally competent” or “having to work hard” all of
the participants in the study had a rooted commitment to continue in a college preparatory
math and science sequence. All but Alexandria and Mia planned to enroll in the next
programming or engineering STEM CTE course.

All of the young women had definitions of success that did not match how they
described their own ability. As demonstrated in Table 1, all of the young women had
ability in math and science, whether it was documented by their grades, test scores, or
both.

Relationships

Relationships, whether it is with teachers, classmates, or counselors, influences
academic success and student retention in school (Rhodes, Grossman, & Resch 2000;
Lapan, Gysbers, & Sun 1997; Lawson, 2013). Based on the research, as well as my own
observations over the course of my career in education, I purposely included questions in
the interview protocol asking about the relationships the young women had with their
teachers, classmates, and high school guidance counselors. I also included a question about their involvement in STEM extracurricular clubs, because research suggests that extracurricular involvement in STEM activities can fortify student persistence in STEM studies (Bottia, Stearns, Michelson, Moller, & Parker, 2015). Thus, it is not surprising that relationships emerged as a salient theme.

**Relationship with classmates.** None of the young women in my study reported problems with the young men in their classes. They described the usual process most students go through when starting a class in which they do not know the other students—there is a period of awkwardness and then through projects they become acquainted with their classmates. The absence of tension, however, did not equate to camaraderie. With the exception of Alexandria (who stated she had “some friends” in the classroom) and Lisa (who said “some are friendly associates and some are friends”), the majority of the young women did not mention becoming friends with the young men in their class. Observations in Lisa’s and Alexandria’s classrooms support their statements: both young women appeared at ease and frequently spoke with their male classmates.

When asked about her relationship with her classmates, Tegan’s experience was different than those of Alexandria and LF. She spoke of the awkwardness she, as well as her classmates, had at the beginning of the year. “Everyone was kind of awkward, because engineering kids usually aren’t the most social of all.” My observation of Tegan at mid-semester indicated that she was comfortable in the classroom and had a good relationship with the young man who sat next to her. For example, they appeared to talk about the project, as well as talk about non-classroom topics and joke with one another (in a manner very similar to my observation of Alexandria).
Willow spoke about the frustration of not always knowing her classmates’ names and that when working on projects, she was not very good at remembering their names once introduced. She added, “everyone is always really nice and that we get along” and said students frequently consult each other: “Hey, did you figure this out, because I can’t get this on the computer, likewise, “hey, can you help me measure this? or hey, do you remember how to use the calipers?” She stated that this communication happens because often Mr. Brown is engaged in helping students one-on-one, and there is “a lot of working together” to get problems solved.

LF laughed and said, “we [she and her classmates] don’t talk at all. I’m sure they’re nice people, fine people. I don’t know if it is that everyone’s caught up in their own work, just quiet, or afraid to speak.” Although LF did not speak with her classmates, she mentioned a young man outside of class who was responsible for getting her interested in a STEM CTE course. Because of his enthusiasm about his STEM CTE course, she said, “I thought I’d give it a shot.”

Alexandria and Rowan 2 spoke of friends who were not in their STEM CTE course, but who were enrolled in a STEM CTE course at another school. LF talked of friends who had similar interests: “I’m not the only one in my friend group that is interested in STEM. It’s nice to have people you can share interest and emotion with.” Alexandria had “several” friends in both PLTW Principles of Engineering and PLTW Robotics and Computer Integrated Manufacturing. This factor may have counter-balanced her mother’s “nagging,” (of which she was resentful) and influenced her to enroll in a STEM CTE course.
Mia had the perception that the young men in her class were accepting of her presence, but did not typically engage in conversation outside of the course content. She said: “None of the boys are like, ‘why is she sitting next to me,’ . . . . The guys are all pretty respectful of the girls.” But she did go on to say it was different working with a partner who was a girl, “Girls are super chatty, and we talk about other things not related to school. Boys just kind of act normal—I guess you could say they act like they’re guys,” Mia laughed.

Describing herself as a friend to some of her classmates, acquainted with others, and a stranger with a few, Rowan 1 reported that she had not experienced anything negative in her classroom of young men. Despite stating early on that she had not experienced anything negative, Rowan 1 went on to say that being the only girl in the room was not fun and that she felt it had negatively influenced her learning.

**Relationship with counselor.** I collected data after course registration for the next school year and found LF and Lisa were the only young women in my study who had met with their school counselors. In addition to not having met with their counselors, the remaining six young women did not know to which counselors they were assigned.

Rowan 2 and Willow were two of the young women who had not met with their school counselors; they had instead spoken with their advisory teachers about high school course selections. The instructors assisted both students with maximizing the number of classes they could take, including advising Rowan 2 about doubling up on her science courses the following year and suggesting to Willow that she take Astronomy the next year, which is aligned with her current career goal.
Alexandria, Mia, Rowan 1, and Tegan also did not know their counselors. Alexandria reported that she had signed up for her courses for next year by using Home Access and seemed taken aback that she would need assistance selecting her courses. Although Mia did not speak with her school counselor, she did talk about a woman at the previous year’s course fair who asked her if she would like to take a PLTW course. When Mia hesitated, the woman asked Mia if she had Legos at home. Mia said:

I didn’t ever think Legos connected to building things or getting into engineering, but it made so much sense when she said it. We had four boxes full of Legos, and I played with them all the time with my siblings.

In addition to not knowing who her counselor was when I asked, Rowan 1 did not talk with her counselor the previous year about her course choices. She signed up for classes on her own and was placed in a PLTW course. Rowan 1 indicated that she selected the PLTW course, thinking it was Digital Media.

Tegan said that she did not know who her school counselor was, but remembered the location of the Guidance Office. She stated that she had no interest in meeting her school counselor: “School counselors kind of put me off a little bit. I try to take classes that interest me as opposed to the ones that will help my career.”

Lisa and LF met with their counselors, yet said they received no career direction from them. Lisa said her counselor’s comment on a career path in STEM was not substantive. The talk was “not to the point more than when she asked, ‘What are you going to do?’ and then said ‘Well that’s nice.’” Lisa laughed as she said she did not think her counselor even understood the career path of computer linguistics.
Of all the young women, LF reported the most positive interaction with her school counselor. LF said that she had an individual session with her counselor and they discussed steps needed to prepare for the college application process. They discussed colleges, GPA, and letters of recommendation, but nothing specific about her career plans. Despite this, LF had the impression that her counselor would be supportive of her choice to pursue a career in STEM.

**Relationship with teacher.** Rowan 1 was the only young woman in the study to talk about difficulty in her class and with her teacher’s instructional practice. She described her teacher as blunt, but then qualified the statement, saying she does not define “blunt” as necessarily a negative word. Rowan 1 described her class as involving much independent work, because the instructor asks students to turn to other students with questions before approaching him. Within this situation, Rowan 1 said, “in general I feel more comfortable asking a female for help than a male.” Thus, Rowan 1 is often somewhat uncomfortable in class, as she is the only young woman in her class. This could have contributed to her sentiments about the course. “I hate coding. I mean it’s a good class, I just don’t like coding.” These statements typified Rowan 1’s responses. Although she would react strongly, she kept softening her remarks. I was unclear whether she had difficulty talking honestly about how she felt about the teacher and the class, or whether she was conflicted—disliking the material, but not wanting to assert that the instructor was responsible for her view.

Despite preferring female teachers, Rowan 1 said that she did feel comfortable working with Mr. Sipes, her high school Physics instructor, on course concepts. The science teacher has created an atmosphere in which they talk about science as well as
other topics, which helped Rowan 1 feel a sense of ease when questioning this teacher. However, in Rowan 1’s STEM CTE course, a comfortable student/teacher relationship was not evident.

Aside from Rowan 1, the other young women spoke positively of their interactions with their instructors. Lisa said her instructor was “really helpful and supportive and actually made funny jokes.” In fact, LF said she was closer to her STEM CTE instructor than her other teachers. She described their relationship as “very professional. It’s very encouraging; it’s a good relationship.” LF referenced her instructor’s methods, reporting that she liked the tangible aspect of the learning process, which enabled her to “see, experience, and feel the progress and learning.” She said this approach was unlike the teacher-directed process she had experienced before when a teacher says, “Here is the next project, and I’m going to walk you through the next step. And here’s the test; and you need to study for the test.” The esteem in which Lisa and LF hold their instructors and the benefits they perceive in their teaching methods could be a contributing factor to their high achievements in these course.

As expressed by Lisa, other participants acknowledged that an instructor’s sense of humor was a positive attribute. Rowan 2 smiled as she reported that both her instructor, as well as the young men in the classroom, often tell bad puns. She seemed to be amused by this and implied that it made the class more informal and enjoyable.

Tegan spoke of the enthusiasm her instructor had for the subject matter he was teaching, stating that she noticed this from her first meeting with Mr. Brown when he was trying to recruit students for his class. It was evident in my observation of the class that Tegan admired “Brown,” as she called him, and that Mr. Brown was fond of her—this
was observed in his playful conversations with her as he would circulate about the room. She said she enjoyed the class because Brown engaged them in activities that had them “actually applying the things you learn in class.” Tegan went on to say that “you don’t feel the need to learn concepts as much in math and physics as you do in engineering.” She spoke energetically about one of her favorite activities at the beginning of the year—a group activity in which students followed the engineering process of brainstorming, developing a solution, designing the object, and then recording this information, and their results in their engineering notebook. This activity involved the team designing a paper airplane. Teams then competed against one another to see which airplane design could achieve the greatest distance. Tegan, a young woman who appears to thrive on competition, described this activity enthusiastically.

Mia described her instructor as a “pretty great teacher.” She said he approached her at a basketball game asking her what classes she planned to take the following year, and after her conversation with him, she decided to sign up for his STEM CTE class. One of the things she commented on was that her instructor “treats all of his students the same . . . there’s not an obvious teacher’s pet, which is pretty good.”

Rowan 2 said, in her quiet style, that she does not talk to her instructor much, but described him as being “really nice and helpful.” Willow also said her instructor was helpful and flexible with deadlines, adding that “he listens very clearly when you’re telling him that you’re struggling.” She said that he “will actually sit down and say, ‘What exactly do you need?’” This approach contrasts that of many of her other teachers outside of CTE who give students packets, but do not take the time to explain the concepts behind the material. Taking the time to sit down and talk on a one-to-one basis
with students was a trait Willow clearly admired in her STEM CTE instructor. Both Rowan 2 and Willow also said they liked that their classes were self-paced, which meant they could work ahead and not have to wait for others to finish an aspect of the project. Willow, in particular, spoke of the frustration of having to slow down to wait on others who, in her opinion, were not willing to work hard.

Alexandria smiled as she described her instructor as a “cool dude.” She mentioned, as did other participants, that her instructor had encouraged female students to participate in STEM activities beyond the classroom. An example was a flyer that her instructor gave to several of the participants about an engineering event geared toward young women occurring at the local university.

Many of the young women appreciated their instructors’ sense of humor, the time they took to have individual conversations with them, as well as equal treatment with the young men in the classroom. Also, all spoke of the teaching style of their instructors—these styles consistently characterized the teachers as facilitators rather than lecturers and directors of class work and homework assignments. I also observed this teaching style while in the classrooms. This teaching method resonated with all participants except Rowan 1 who preferred a more didactic approach.

**Forming relationships by participating in extracurricular STEM activities.**

Three of the eight young women in my study were participating in STEM extracurricular activities at the time of the data collection. Tegan belonged to the Technology Club at Rockledge High School. Technology Club takes in donated computers that are either obsolete or nonfunctioning and refurbishes them for distribution in the high school.
Both Lisa and Rowan 2 were members of First Robotics, often referred to as FIRST. Lisa was participating in her third year in FIRST. She said her first year was spent working on marketing—FIRST is an expensive program and local clubs must fundraise to pay for their robot, as well as transportation and lodging for the competition. During her second and third year, Lisa participated in programming the robot, as well as the mechanical work. Rowan 2 was also in her third year with FIRST. In FIRST, Rowan 2 has participated in programming, designing flags for the robots, as well as scouting the competition at the competitive events. When we met, she was assisting with presenting programs about FIRST to middle school students.

In addition to her participation with FIRST, Rowan 2 participates in Science Olympiad, taking a key role on the Wind Power team—designing blades, building the turbine, and making a plan to provide electricity to the device. She has also participated in astronomy and programming events.

Although Alexandria, Mia, Rowan 1, and Willow were not in STEM extracurricular activities at the time of the study, they have participated in the past. Both Alexandria and Mia have been members of Science Olympiad teams. Rowan 1 attended summer camps at CTC; she attended Welding Camp, which was a STEM-related activity. Willow reported that she has attended Saturday Morning Science programs at the local university. LF was the only student who was not involved in a STEM extracurricular activity, nor did she mention a past activity.

All of the young women who are currently participating in a STEM extracurricular club or who have been a member of a STEM team in the past indicated that they had fun while learning about science and engineering. Each of the events
allowed them to connect with students who had similar interests as well as faculty members they may or may not have been familiar with beforehand and each of these students re-enrolled in their STEM CTE program of study.

Roadblocks

The theme of roadblocks was a salient theme for all participants. In the analysis of the data, this theme was present in all of the young women’s interviews. I utilized predetermined codes based on the work of Hall and Sandler (1982), in the development of this theme as well as codes based on emerging information.

Devalued. Only Rowan 2 shared a story of an incident in which she felt devalued. She described this incident as “kind of frustrating,” as she furrowed her brow. She was on an engineering field trip at the local university. The bus to pick up the students had been delayed. While the students waited, she reported that even though the boys were really not friends with one another, they all clustered together and began talking about airplanes and nuclear bombs. Rowan 2 stated that both topics have much in common with nuclear engineering, an area about which she considers herself knowledgeable. She reported that her frustration came from not being included in the conversation even after trying to be—as if she had nothing to contribute.

Fear and isolation. A few participants discussed feeling fear/isolation during their STEM experience. Rowan 1 spoke the most about this topic. After speaking about her perception of being deficit in math, she stated:

a lot of the times math teachers, they teach the lesson and just kind of say go do it. That doesn’t exactly help me, because often I want to ask for help, but I’m scared
to do so. Not out of particularly a logical reason, but I just don’t like asking for help.

Although she did not talk specifically about being fearful to ask questions in her STEM CTE class, I reflected on my observation of Rowan 1 in class and speculated: Rowan 1’s inability to progress past her first two lines of code during the 90 minutes of class and her reluctance to ask questions (even though the instructor walked near her desk multiple times) indicated anxiety atypical of the class as a whole. She openly stated that it was difficult being the only “girl” in class and “in general I feel more comfortable asking a female for help than a male.” These factors created a self-imposed pressure emphasized by her statement, “I often felt like I had to prove myself in the class, that I wasn’t the girl that was in there just by mistake.”

None of the other young women indicated that they had to prove their ability, but all stated that they were surprised by the low number of young women in their class. Two of the participants were one of two young women in the class; three of the participants were in a class together; and the other three young women were in the STEM CTE class by themselves. Alexandria stated:

It’s really jogging, but that’s not the right word. Like I knew about the gender disparity in the STEM fields, but it really never came to fruition until I walked in and realized I was the only girl in my class, so then that’s really when the reality hit me.

**Perception of individuals in STEM careers.** All of the young women in my study were asked to picture a STEM workplace and to describe the individuals working there. Although two of the young women, Rowan 2 and Tegan, pictured architects,
construction workers, and scientists (who are overrepresented by men in the U.S. workforce) at work, neither described in the imagined settings a disparity between the number of women and men.

The remainder of the young women in the study either talked about stereotypes or workplace disparities between the number of women and men employed. Rowan 1 first said she envisioned “a lot of logically minded individuals, probably equal amounts of men and women, different races” and then concluded with “that’s ideal.” When asked what she felt was a realistic vision, she told me about a day that she had to accompany her father to work. She said that everyone was in cubicles and there was not much creativity there, “just people doing their jobs.” She concluded by stating that “it was mostly boys” working there.

Lisa said the vision that comes to her mind is welding—she does not know why, but it is mostly people doing things with their hands and they are predominately men. Mia laughed as she said, “I picture men.” Willow acknowledged that:

Probably what first jumps to mind is the stereotype that they are all wearing white lab coats (she laughed), maybe some of them have glasses (she laughed again). Probably what comes later is more men than women, labs, research tubes, probably a lot of chemistry stuff…kind of like the university’s Life Science building.

Alexandria stated that as she thought about her father’s lab, the professors were men and some grad students were women. She also spoke about a Verizon commercial that she saw. The commercial followed a girl as she was growing up. Alexandria said it was obvious that the girl had an interest in science “as she was playing with seashells
assembling a solar system in her room and she was also trying to grow stuff. Then her parents would constantly be, like, “this is out of control. Let your brother handle it.” Alexandria concluded by saying that this is a problem bigger than an individual and that “if society as a collective would encourage young girls to follow, not necessarily be more involved in science, but, follow their passions, then I feel like we’d see a higher retention and it wouldn’t be stifled at a young age.”

Summary

The young women in my study represent a subset of the young women across the country in STEM CTE programs. They shared their perspectives and experiences in several different STEM CTE courses and four themes emerged: role models, perception of ability and perseverance, relationships, and roadblocks. These themes are interconnected, such that the young women—despite knowing each could be the only young woman in future STEM CTE classes, and also aware of the rigorous course work that is in their future—had positive outlooks and were not swayed to switch to an “easier” career pathway. Even Rowan 1, who struggled academically in math and science, as well as in her STEM CTE course, remained steadfast in her desire to move ahead in her STEM CTE pathway.

In the next chapter, I explore in greater depth the interconnections among the themes and answer the study’s research question. Guided by my theoretical and conceptual frameworks, I will interpret the finding, suggest implications for practice and policy, discuss conclusions, and recommendations for future research.

LF was not asked the question regarding her vision of the STEM workplace.
CHAPTER 5: DISCUSSION AND CONCLUSIONS

I want to make sure we use all our talent, not just 25 percent. Don’t let anyone rob you of your imagination, your creativity, or your curiosity. It’s your place in the world; it’s your life. Go on and do all you can with it, and make it the life you want to live.

Mae Jemison, First African American Woman in Space
(10 inspiring quotes, n.d., p. 2)

Introduction

The purpose of my study was to examine factors that influence young women’s decisions to remain in a STEM CTE program of study. One overarching question framed my research: What influences young women to re-enroll or leave STEM CTE programs of study for another academic year at one CTE school in a small Midwest city?

As I coded the participants’ interviews, I utilized predetermined codes based on my conceptual framework, self-efficacy, and my theoretical lens, liberal feminism. I also was cognizant of emerging codes as I analyzed the in my study. Classroom observations, interviews, and artifacts consisting of the young women’s grades and test scores were used to triangulate the data.

This chapter will begin with a collective summary of the participants in my study followed by a discussion of my findings and implications for policy and practice, recommendations for future study and a brief conclusion.

Study Participants

All of the young women in my study had at least one parent who was employed or had been employed in the STEM field. Two of the participants had both parents in jobs as science professors and another participant’s father was an engineering professor—all working at the local university. The remaining participants, with the exception of one,
had a parent or parents who were currently working in the fields of science, medicine, engineering, or IT.

Participants in my study all reported having parents who were supportive and encouraging of their career paths whether their choice was in STEM or another area. Two of the eight young women had opted out of STEM studies in the following school year stating that their interests were in different areas—journalism and working in the ministry.

Each of the young women had AP or MAP test scores that indicated either a proficient or advanced level in both mathematics and science. All of the young women had grades of a C- or higher as semester grades in their math, science, and STEM CTE course, with the majority of young women earning As and Bs both semesters. All of the young women except one were enrolled in advanced coursework in mathematics and science.

Only one student reported significant difficulty in her STEM CTE class. This difficulty was also reflected by her grades and my observation of her struggle with the coursework in her classroom. Despite this, she decided to persist in math, science, and STEM CTE—she signed up for Geometry, Honors Biology, as well as an upper level PLTW course for the following school year.

Discussion

As a reminder, self-efficacy is at the root of social cognitive theory. It refers to "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). In this way, the majority of the young women in my study demonstrated self-efficacy. In
addition, the young women appeared to have a growth mindset (Dweck, 2006) and grit (Duckworth, 2016; Duckworth, Peterson, Matthews, & Kelly, 2007). In particular, nearly all of the young women persisted. This was despite viewing their grades as deficit, not having a sense of camaraderie with the young men in their classroom, and often being the only young women in their class. Overall, they demonstrated a commitment to STEM over many years (Duckworth, 2013).

All of the young women had high expectations for themselves and if they did not receive an A in math, they felt their math ability was a deficit. Even the young woman who received an A in math both semester in her AP Calculus BC course (this is typically a class seniors with advanced math ability take) described herself as “marginally competent.” I am unsure whether this was modesty on the part of the young women or how they defined success. But, regardless of how they perceived their grade, the young women who were interested in pursuing a career in STEM had a growth mind-set. They viewed it as advantageous to continue preparing themselves for STEM postsecondary studies by registering for the next college preparatory math and science class as well as the following STEM CTE course.

All but one young woman in my study had low opinions of their math abilities, consistent with Bandura’s (1997) research. Likewise, most had low opinions of their science abilities (Lupart et al., 2004). The exception were two students—one who, in a manner I considered self-assured, described her science ability as “very proficient,” and another who felt her science ability was greater than her math. Although grades are not always a good proxy for ability, the young women perceived their math and science ability as less than grades and test scores indicated.
STEM CTE instructors appeared to influence all of the young women’s self-efficacy. The majority of young women felt encouraged by their instructor and completed the tasks assigned, with many of them earning As in their STEM CTE course. They saw value in learning the engineering process and applying the principles to other assignments.

Another contributing factor to the young women’s self-efficacy may have been the presence of at least one or more family members holding jobs in STEM. The encouragement they received, as well as stories that may have been shared by family members, could have assisted in the young women’s belief that they could be successful, instilling a growth mind-set and grit, which all the young women appeared to possess.

Although instructors were largely supportive, not all of the young women had a positive experience in their STEM CTE classroom. One young woman in particular appeared to have been adversely influenced by her experiences in an academic math class, as well as her STEM CTE course. Rowan 1 described herself as afraid to ask questions in her math class and this fear seemed to have translated to her STEM CTE course. Yet, she intended to take the next course in her math, science, and STEM CTE program of study.

Rowan 1’s decision to enroll in a STEM CTE course the following year was perplexing as the course she planned to take required a considerable amount of programming, a subject she said she disliked. Perhaps she did not wish to disappoint her parents. Or her test scores assisted in her development of a growth mind-set and afforded her the grit to continue to the next level in math, science, and STEM CTE coursework.
despite an articulated dislike of the subject matter. Her reasons for continuing might also have been to prove that she had not made a mistake in choosing a STEM pathway.

Although it is not conclusive, the two young women who decided to not enroll in a STEM CTE course for the following year may have decided the career path was not one they were interested in pursuing. Alexandria had been forthright in stating that she took a STEM CTE class to appease her mother. Mia’s choice to not continue in STEM CTE was her desire to pursue a career in the ministry. Mia did not voice confidence in her math and science ability, which may have been an additional reason that she did not choose to follow in her STEM CTE pathway.

The majority of young women felt challenged in their STEM CTE course. They persevered despite their perceived low ability in academic math and science classes. (N.B., each earned a C+ or higher second semester in their STEM CTE course.) Perhaps the challenging nature of the STEM CTE course contributed to their level of grit and desire to continue in their STEM CTE program of study. This is consistent with research that has shown that young women who have self-efficacy in STEM typically perform better and persist in the face of challenge than those with lower STEM self-efficacy (Britner & Pajares, 2006; Felder, Felder, Mauney, Hamrin, & Dietzm 1995; Linver & Davis-Kean, 2005; Mau, 2003; Zeldin & Pajares, 2000). These studies support the assertion that all the young women in my study, even the young woman who struggled in her STEM CTE course, had a growth mind-set and believed that she could be successful in the next course in their STEM CTE pathway.

Young women experienced feeling devalued, fear, isolation, as well as a negative perception of individuals in STEM careers. These negative experiences should not be
equated with challenging academic content, they are challenges in their own right, but should not be part of schooling. Although reports of fear were not pervasive, most were surprised by the lack of young women in their STEM CTE class. The number of young women was between one and three in each STEM CTE class. None of the young women reported a negative encounter with the young men in class, however camaraderie was not a common as they described their relationships with their classmates.

The lack of young women in the classroom mirrored participants’ descriptions of the STEM workplace (Mead & Mattraux, 1957). The majority of young women in the study pictured STEM workplaces as ones in which most employees were men. Their pictures were informed either by visiting a parent’s workplace or by watching television. Based on their observations, several young women acknowledged the isolation and sexism they will have to face if they choose to pursue a career in STEM.

The findings in my study suggest that both self-efficacy, as defined by a young woman’s willingness to continue in their STEM CTE program of study, and sexism played a part in the young women’s STEM CTE experience and future plans. The majority of young women did not view their ability on par with the grades they received, but they did experience a higher self-efficacy when completing their coursework. Although all the students but one reported favorable relationships with their instructors, the themes of being devalued, feeling fear, experiencing isolation as well as perceiving the STEM workplace as a masculine environment were still present.
Implications for Policy and Practice

In this section, I discuss the implications for policy and practice of my findings. I also acknowledge that these result partially from the perspective I have as an education practitioner at the CTC.

Researchers found that having role models is an important factor for young women to persist in STEM fields (CITE). The young women in this study had role models who made a positive difference in their academic STEM experiences. All of the young women in my study had a family member who they identified as a role model. But, this is not a possibility for all students. As such, we cannot increase participation of young women if we rely solely on young women having parental role models and mentors. Therefore, it is important for educators to assist in providing STEM mentors for young women. Many communities, like the one where this study took place, have universities, colleges, and industries that can be tapped for mentors. Although role models do not need to be women, having women as STEM role models can be of value. Young women could listen to them describe their jobs or provide opportunities to visit their workplace and shadow them. This experience could raise the self-efficacy beliefs of young women (Zeldin et al., 2008). In addition, this may assist young women to re-imagine the STEM workforce as inclusive of women, like themselves.

The lack of women role models in the sciences may be why it is difficult for young women to envision themselves as scientist (Moriarty et al., 2013). There are existing resources that could serve to facilitate mentor and role model identification for STEM students. For example, acquiring role models for all STEM students should be a goal of the Project Lead the Way (PLTW) Community Partnership Team. PLTW
Community Partnership Teams are required by the national PLTW for every school offering PLTW courses, which include the STEM courses that are offered at CTC. The team’s membership consists of parents and students, as well as individuals employed in the STEM industry. Because of the ties with industry, the team could be an invaluable resource that has the potential to encourage all genders to pursue careers in STEM. It is also important for instructors to create mentoring opportunities, job shadowing, guest speakers, and industry tours that appeal to all genders.

Quality teachers can also serve as role models. Although the majority of the young women in this study have shown an overwhelmingly positive regard for their male instructors, school districts must be diligent in their efforts to recruit women as math, science, and STEM CTE instructors. This recruitment may need to be extended beyond a January Career Fair typical in many schools, like the one in this study, to active recruitment at career centers on college campuses.

All of the young women in my study reported little to no relationship with their school counselor. This was alarming, as school systems and parents depend on school counselors to advise students regarding career pathways. The mandated school counselor-to-student ratio in Missouri is 1:500; and 1:301-375 is recommended (State school counseling mandates, n.d.). School counselors’ responsibilities extend beyond career counseling, as they are often overwhelmed with students in crisis, college applications and recommendations, as well as tracking students for graduation.

The breadth of responsibilities and the Missouri recommended ratio leave little room for effective career counseling. Educators at all levels must lobby their legislators for reform in the counselor-to-student ratios. Lobby efforts must also include increasing
school funding so that school districts can hire additional school counselors. Lessening the number of students served by one counselor would allow for more substantive conversations about career choices. In addition, lowering the ratio would create more capacity for school counselors to invest time needed to develop relationships with their students.

Because of the lack of a relationship with their school counselors, it is unclear whether the counselors at Rockledge High School had the training about the issues young women encounter when pursuing coursework and a career in STEM. If school counselors are not trained about these issues, I recommend that they receive professional development in this area; it could allow counselors to speak with authority and support young women who have the potential to pursue STEM education.

STEM CTE instructors also need additional professional development. This professional development should include education about Dweck’s (2006) theory of a fixed versus a growth mind-set as well as Duckworth’s (Perkins-Gough, 2013) research on grit. Professional Learning Teams already exist in many schools, including CTC. The aforementioned topics should be discussed in these team meetings. Also if instructors, as well as individuals in the STEM workforce, could share their own academic and career struggles with students, this could serve to increase the grit needed for women pursuing a career in STEM (Will, 2016).

Many of the young women in my study lacked self-confidence in their math and science ability. According to Jones (2015), young women need to be encouraged to “think like a scientist.” Jones argued that parents often, without realizing it, make comments that reflect gender bias. He believes that schools can take steps to minimize
the effect of cultural conditioning (and stereotype-threat) and boost girls’ confidence in their math and science abilities. Providing parents as well as instructors with information on gender bias could be helpful so that they are more mindful in their conversations and do not discourage young women’s interest in STEM.

In addition to young women developing grit, they need to experience a classroom that is welcoming. STEM CTE instructors should be encouraged to include team building exercises periodically throughout the school year. Ice breaker activities could be included at the beginning of the year so that students get to know one another before embarking on projects. Also, instructors must be trained in sexual harassment so that they are able to recognize behavior that a reasonable person would consider hostile, threatening, or sexist.

**Recommendations for Future Research**

If I were to conduct similar research in the future, I would increase the number of participants by including first-time students enrolled in STEM CTE courses at all the WVPS district high schools. This could yield a more diverse population academically, economically, and racially. In doing so, issues of intersectionality could also be explored.

My protocol did not include questions related to stereotype-threat, therefore, I am unable to consider whether this was a factor influencing student perseverance. I advise future researchers to include questions regarding this topic. Additionally, I did not explore the attitudes of STEM CTE instructors regarding their view of young women’s to succeed in their classrooms. This data could further inform possible implications for policy and practice.
Very little research has been conducted on the retention of young women in STEM CTE programs of study, therefore, there are many areas for future researchers to study. I suggest additional qualitative research as well as quantitative or mixed method studies. Quantitative and mixed method research would generate more generalizable findings that could expand the reach of research in this area. I also recommend longitudinal research to track participants to see if they “leaked” from the pipeline at the juncture between high school and college and during their college years.

**Conclusion**

The U.S. Department of Education’s Office for Civil Rights (OCR) and Career, Technical, and Adult Education (OCTAE) recently penned a Dear Colleague Letter to recipients and sub-recipients of federal financial assistance, including all programs receiving federal financial assistance with CTE and programs awarded grants under the Carl D. Perkins Career and Technical Education Act of 2006 (Llamon & Uvin, 2016). Correspondingly, OCR’s mission includes the right of equal access to all federally funded programs and activities through the enforcement of civil rights laws, including Title IX, which prohibits discrimination on the basis of sex (Llamon & Uvin, 2016). The focus of the Dear Colleague Letter was the elimination of discriminatory practices in CTE with an emphasis on “proactive steps to expand participation of students in fields where one sex is underrepresented” (Llamon & Uvin, 2016).

The letter began by underscoring access for all to high-quality CTE programs both at the secondary and postsecondary levels; access is necessary because it is paramount to achieving equity as required by U.S. civil rights laws. The U.S. civil rights laws ensure that all students must have access to the full range of CTE offerings,
including those classified as nontraditional relative to gender. Programs mentioned in the letter encompass “high-growth fields, such as nursing, advanced manufacturing, information technology, computer science, and cybersecurity, for both men and women” (Llamon & Uvin, 2016). Findings from my study reinforce why such a Dear Colleague Letter remains necessary.

Despite gender parity in fields like biology and chemistry, where young women make up close to or more than half of those receiving bachelor’s or postgraduate degrees, women are still underrepresented at the secondary and postsecondary levels in all other fields—particularly engineering and computer science (The National Coalition for Women and Girls, 2012). Although significant progress has been made with regard to the persistence of women in STEM fields—28% of STEM jobs are held by women and 37% of STEM college graduates are women—the percentage of women earning computer science and engineering degrees has decreased during the last few decades (The United State of Women, n.d.).

Studies like mine are important because high school is one of the junctures at which young women can begin to access STEM CTE curricula. Enrollment in STEM CTE courses reinforces students’ learning and provides lab experiences in which they can apply concepts acquired in their academic studies (National Association of State Directors of Career Technical Education Consortium, n.d.), as well as prepare for future coursework and possible careers in STEM. The young women in my study valued their STEM CTE courses, as they provided the opportunity to apply academic math and science and engage in activities in which they might participate in their future careers.
Given the nature of CTE programs, I argue that increased participation in high school STEM CTE programs could lead to larger numbers of women in postsecondary STEM programs, which, in turn, could result in higher numbers of women in the STEM workforce. A STEM workforce that includes more women could enhance creativity, quality in team problem-solving, as well as superior corporate performance in areas including sales, worker productivity, and total company assets (NSF, 2000; The Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development, 2000). My study provides insight into factors that influence some young women to continue to enroll in STEM courses; I hope that they continue to do so in the future. Additional research is necessary to expand upon these findings.

I learned that the young women in my study possess grit and a growth mind-set. They persevered when confronted with academic challenges as well as difficult problems presented in their STEM CTE courses. They were determined to continue in their STEM CTE courses despite sometimes feeling devalued, fearful, and isolated in their classroom.

Encouraging young women to pursue STEM CTE studies, as well as persist, must be a goal of all educators. Teacher and school counselor professional development that includes strategies to build relationships among and between students and educators, recognize and prevent student behaviors that result in an unwelcoming atmosphere, and educate about the lack of women in STEM careers and its global implications is imperative.

Although this is beyond the scope of my study, I believe that STEM CTE instructors must develop a network of individuals (especially women) in postsecondary
STEM and the STEM workforce to extend the STEM CTE pipeline beyond high school to support young women to continue their studies in fields dominated by men. This network could provide young women with job shadowing, mentoring, and exposure to the STEM workplace.

Finally, my study included a small number of young women, because a small number were enrolled in STEM CTE courses. Understanding why so few are in these courses and what can be done to change that is necessary. The young women in my study were fortunate to have role models and mentors in their own families, perhaps they can serve as role models for students in elementary and middle school to encourage those girls to pursue STEM education. Sharing their stories of struggle and success could prove inspiring for younger students, resulting in an increased enrollment in math, science, and STEM CTE courses.
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RETENTION OF YOUNG WOMEN IN HIGH SCHOOL STEM CTE

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Appendix A

Parent Email

Dear Parent/Guardian,

I’m writing to ask your permission for your daughter to participate in a study on the retention of young women in STEM (Science, Technology, Engineering, and Math) CTE (Career and Technical Education) programs of study. Your daughter has been asked to participate because she is a first-year student in a STEM CTE course.

Gender inequity in STEM careers is to a significant degree the result of greater numbers of women than men leaving the study of math and science in the junctures between high school, college and the workforce. Increased retention of young women in high school STEM CTE programs has the potential to weld a patch in the STEM pipeline juncture between high school and postsecondary studies.

Participation in the research study is voluntary and your daughter may withdraw from the study at any time without penalty. All students participating in the study will be given a pseudonym so that each participant’s identity will be protected.

Attached to this email, you will find a parent consent form. This form must be signed by you in order for your daughter to participate in the study. Additionally, a Columbia Area Career Center (CACC) Student Services staff member will be talking with your daughter about participation in the study. Your daughter will be given a child assent form (student permission form) to sign and also a hard copy of the parent permission form to bring home to you. Both the student and parent form must be signed before your daughter can participate in the study. Signed permission slips can be turned in at the CACC high school office.

My hope is that you will grant permission for your daughter to participate in the study. The study’s findings could inform a plan to transform CTE into a setting in which more young women complete a STEM CTE program of study in high school and enroll in a related major at a college or university.

Please feel free to contact me at 573-214-3800, extension 29455, if you have questions.

Sincerely,

Rebecca Wimer-Pisano
Appendix B

CHILD ASSENT FORM TO PARTICIPATE IN A RESEARCH STUDY

INVESTIGATOR’S NAME: REBECCA WIMER-PISANO

PROJECT # 2003838

STUDY TITLE: RETENTION OF YOUNG WOMEN IN HIGH SCHOOL STEM CAREER AND TECHNICAL EDUCATION
This is a study guided by the research question: “what influences young women to re-enroll or leave STEM (Science, Technology, Engineering, and Math) CTE (Career and Technical Education) programs of study for another academic year at one CTE school in a small Midwest city?”

Why YOU are invited

You are invited to be in this study because you are a first year female student in a STEM program of study.

What will happen?

If you agree to be in the study, you will be asked to do the following things: participate in an interview that will be approximately 45 minutes in length. The interview will be audio recorded, with your permission, and a transcript will be provided to you so that you can confirm the accuracy of your interview responses. Also, your academic transcript and attendance records will be used in the study as well as a 90 minute observation of your STEM CTE classroom.

Can anything good happen to me?

Your participation will benefit instructional practices that increase retention of girls in STEM CTE programs of study.

What if I don’t want to do this?

If you say you do not want to be in the study, you just have to tell the CACC counselor. No one will be mad at you. You can also say yes and later if you change your mind, you can quit the study. The choice is up to you and your parents.

Who will know my answers or see my information?

Your interview answers, academic transcript, and attendance records will be kept in confidence with the exception that your parents have the option to request a copy. All participant answers will be coded so that readers of the study will not be able to identify participants.
Who can I talk to about the study?

You can ask questions any time. You can ask now. You can ask later. You can talk to me or you can talk to someone else at any time during the study. Here is the telephone number to reach me 573-214-3800, ext. 29455, Rebecca Wimer-Pisano.

________________________________________________________  __________________________

Signature of Student                                                                 Date

A copy of this form will be given to you.
Appendix C

Parental Consent Form

PARENTAL CONSENT FORM TO PARTICIPATE IN A RESEARCH STUDY

INVESTIGATOR’S NAME: REBECCA WIMER-PISANO

PROJECT #2003838

STUDY TITLE: RETENTION OF YOUNG WOMEN IN HIGH SCHOOL STEM CAREER AND TECHNICAL EDUCATION

INTRODUCTION

I’m asking for permission that your student be allowed to participate in a research study. This research is being conducted to determine what factors contribute to a young woman’s decision to re-enroll in a STEM (Science, Technology, Engineering, and Math) CTE (Career and Technical Education) program of study. You have the right to be informed about the study procedures so that you can decide whether you want to consent for your student to participate in this research study. If any of the information is unclear in this form, please ask the researcher to explain any words or information that you do not understand.

You have the right to know what your student will be asked to do so that you can decide whether or not to include your student in the study. Your student’s participation is voluntary. They do not have to be in the study if they do not want to. You may refuse for your student to be in the study and nothing will happen. If your student does not want to continue to be in the study, she may stop at any time without penalty or loss of benefits to which they are otherwise entitled.

We ask that you read this form and ask any questions that you may have before allowing your student to participate in this study.

DESCRIPTION OF THE RESEARCH

Your student has been invited to be in this study because she is a first year student in a STEM program of study. The purpose of the study is to determine what influences young women to re-enroll or leave a STEM CTE program of study.

PROCEDURES OF THE STUDY

If you agree to have your student be a part of the study, she will be asked to do the following things: participate in an interview about her experiences in her STEM CTE classroom and her intention to re-enroll in another STEM CTE class. Interviews will be approximately 45 minutes in length. All interviews will be completed by the end of March 2016. I will also conduct classroom observations that will be 90 minutes in length.
(the length of one class period). The observations will note your student’s location in the classroom, interaction with classmates and the instructor, as well as a description of the classroom activities and their participation. As the assistant director of CACC, I will have access to your student’s grades and attendance. I will collect this information so that I can view interview transcripts, observations, student grades and attendance together to make sense of the data and answer the question of why young women stay or leave STEM CTE programs of study. All data (student interviews, observations, and artifacts) will be saved under a pseudonym to protect the confidentiality of your student. The use of a pseudonym should minimize the risk of discomfort to your student.

**HOW LONG WILL MY STUDENT BE IN THE STUDY?**

This study will take approximately 9 months to complete. Your student can stop participating at any time without penalty.

**HOW MANY PEOPLE WILL BE IN THIS STUDY?**

Fourteen students are being asked to participate in the study.

**WHAT ARE THE BENEFITS OF THE RESEARCH?**

Your student’s participation will benefit instructional practices that may increase retention of girls in STEM CTE programs of study.

**PARTICIPATION IS VOLUNTARY**

Participation in this research study is voluntary. You may refuse to allow your student to participate or withdraw your student from the study at any time. Your student may also refuse to participate or withdraw themselves at any time. Your student will not be penalized in any way if you decide not to allow your student to participate or to withdraw your student from this study.

**WHAT ABOUT CONFIDENTIALITY?**

I will do my best to make sure that your student’s answers to these questions are kept private. Information produced by this study will be stored in my office in a locked file. The code key connecting your student’s name to specific information about you will be kept in a separate, secure location. Information contained in your student’s records may not be given to anyone unaffiliated with the study in a form that could identify your student without your written consent, except as required by law.

Although measures are being taken to protect the confidentiality of your student, the potential risks to your student if confidentiality is breached is possible embarrassment regarding her answers to the interview questions, her grades, attendance, or the classroom observation notes.
With her permission, your student will be audio recorded during the interview. You will be given the opportunity to view or listen to the audio recordings before you give your permission for their use if you so request.

**WHO CAN I TALK TO ABOUT THE STUDY?**
If you have any questions about the study or if you would like additional information, please call Rebecca Wimer-Pisano, 573-214-3800, ext. 29455 or email rdwtz3@mail.missouri.edu. Information can also be obtained from my faculty advisor, Jeni Hart, 573-882-8221 or email hartJL@missouri.edu.

You may contact the University of Missouri Institutional Review Board (which is a group of people who review the research studies to protect participants’ rights) if you have questions regarding your student’s rights as a research and/or concerns about the study, or if you feel under any pressure to enroll your student or to continue to participate in this study. The IRB can be reached directly by telephone at 573-882-9585 or email umcresearchirb@missouri.edu.

I have read this parental consent form and have been given the opportunity to ask questions. I give my permission for my student to participate in this study. I understand that, in order to for my student to participate, they will need to be able to give their consent also. I understand that participation is voluntary and I can withdraw my student at any time without penalty or loss of benefits. You will be informed of any significant new findings discovered during the course of this study that might influence your student’s health, welfare, or willingness to continue participation in this study.

Parent/Guardian signature_________________________________ Date:

____________________

Student’s Name: _______________________________________

*You will be given a copy of this consent form to keep for your records.*
Appendix D

Observation Protocol

Date: ________
Time: ________
Length of activity: ____ minutes
Class: ________
Participant/s:
__________________________________________________

Physical setting: Location of participants:

Description of activities:

Interactions:

Number of times young women were called on in class as compared to young men:

Conversations young women or men had with their instructor:

Criticism of young women related to their lack of skill in the subject matter:

Instructor coaching young women versus completing the work for them:

Additional Notes:
Participants’ comments:

Researcher’s observations:

Reflective Notes:
Appendix E

Interview Protocol

1. Background information—age; grade in school; sending school; self-reported semester grades in science and math; self-reported classroom attendance; siblings who have taken CTE classes; parents’ occupation; and current CTE class.

2. In a few sentences, please describe your experiences in math and science.

3. How would you describe your math and science ability?

4. Tell me about your current CTE class.

5. What factors contributed to your decision to enroll in your current CTE class?

6. Were you influenced by others to enroll in your current CTE class?

7. How is your current CTE class like or different than the math and science classes you have taken?

8. How would you describe the difficulty of your current CTE class?

9. How would you describe your relationship with your instructor and other students in the class?

10. Most of the students in your classroom have been young men. How has this influenced your learning experience and your decision whether to re-enroll in a STEM CTE class?

11. Describe to me memorable events that will help me understand what you are learning in your CTE class and your thoughts about that experience.

12. Reflecting on your experience in your CTE class, is there anything you wish you could change?
13. Do you plan to enroll in a CTE class next year and if so, what class do you plan to take? What influenced this decision?
Appendix F

Interview and Observation Codebook

<table>
<thead>
<tr>
<th>Devaluing</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Young men</td>
</tr>
<tr>
<td>W</td>
<td>Young women</td>
</tr>
<tr>
<td>Asst</td>
<td>Type of assistance given – coaching vs. work being done for the CE?</td>
</tr>
<tr>
<td>CE?</td>
<td>Close ended question</td>
</tr>
<tr>
<td>OE?</td>
<td>Open ended question</td>
</tr>
<tr>
<td>Called by N</td>
<td>Instructor calling student by name</td>
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<tr>
<td>Dress</td>
<td>Commenting on attire</td>
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<td>Det Feedback</td>
<td>Detailed Feedback</td>
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<tr>
<td>Detail Instru</td>
<td>Instructor giving detailed instructions women</td>
</tr>
<tr>
<td>Encourage</td>
<td>Encouragement to take on more difficult tasks</td>
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<tr>
<td>Eye</td>
<td>Instructor eye contact</td>
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<tr>
<td>Ignor Comm</td>
<td>Ignoring comments</td>
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<tr>
<td>Inter</td>
<td>Student being interrupted</td>
</tr>
<tr>
<td>Jokes</td>
<td>Sexist jokes in the classroom</td>
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<tr>
<td>M show W</td>
<td>Young man being asked to show young woman how to do a task</td>
</tr>
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<td>Neg BL</td>
<td>Negative body language</td>
</tr>
<tr>
<td>Seriousness</td>
<td>Not taking comments seriously</td>
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<tr>
<td>Singling out</td>
<td>Singling out or making generalizations</td>
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<td>Stereo</td>
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**Self-Efficacy/Mind-Set**

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<th>Willingness to take on difficult</th>
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<tbody>
<tr>
<td>SE</td>
<td>Student’s belief about their ability to successfully complete a task</td>
</tr>
<tr>
<td>GMS</td>
<td>Demonstrating Growth Mind-set</td>
</tr>
<tr>
<td>FMS</td>
<td>Demonstrating Fixed Mind-set</td>
</tr>
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</table>
VITA

Rebecca Wimer-Pisano was born in north central Missouri in 1956, the first child of a barber and a seamstress. Rebecca’s mother returned to college when she was in junior high school, graduating with a degree in elementary education the same year. Rebecca graduated from high school.

Rebecca’s family valued education and cheered her on as she attended community college and then transferred to what is now Truman State University. Graduating in 1978 with a bachelor’s degree in secondary social studies, Rebecca returned to north central Missouri and taught in a small farming community. In 1981, Rebecca returned to school at the University of Missouri and began her master’s degree in school counseling. There she met the love of her life, a New Jersey fellow, and followed him to New Jersey, finishing her master’s degree in Student Personnel Services at Trenton State College (now College of New Jersey).

Currently, Rebecca is in her 33rd year as an educator. She has served as a teacher, school counselor, and most recently a school administrator. In addition to her years as an educator, Rebecca worked at a women’s center as the Director of Sexual Assault Services and Volunteer Coordinator.

Rebecca is the proud mother of a son, Michael. The family legacy of entering a doctoral program is being passed on—Michael is a first-year PhD student in Immunology at the University of Iowa.